

## 2006 Buick Lucerne CXS

2006 ENGINE Engine Mechanical - 3.8L - Lucerne

### 2006 ENGINE

#### Engine Mechanical - 3.8L - Lucerne

## SPECIFICATIONS

### FASTENER TIGHTENING SPECIFICATIONS

#### Fastener Tightening Specifications

Application	Specifications	
	Metric	English
A/C Compressor Mounting Fastener	50 N.m	37 lb ft
Accelerator Control Cable Bracket Bolt/Nut	16 N.m	12 lb ft
Balance Shaft Driven Gear Bolt		
• First Pass	22 N.m	16 lb ft
• Final Pass	70 degrees	
Balance Shaft Retainer Bolt	30 N.m	22 lb ft
Battery Negative Cable to Engine Block Bolt	25 N.m	18 lb ft
Camshaft Position Sensor Bolt	10 N.m	89 lb in
Camshaft Sprocket Bolt		
• First Pass	100 N.m	74 lb ft
• Final Pass	90 degrees	
Camshaft Thrust Plate Bolt	15 N.m	11 lb ft
Canister Purge Solenoid Valve Bracket Bolt	50 N.m	37 lb ft
Canister Purge Vacuum Switch Bolt	50 N.m	37 lb ft
Connecting Rod Bearing Cap Bolts		
• First Pass	27 N.m	20 lb ft
• Final Pass	50 degrees	
Crankshaft Balancer Bolt		
• First Pass	150 N.m	111 lb ft
• Final Pass	76 degrees	
Crankshaft Main Bearing Cap Bolt		
• First Pass	40 N.m	30 lb ft
• Final Pass	110 degrees	

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**Crankshaft Main Bearing Cap Bolt - Side**

• First Pass	15 N.m	11 lb ft
• Final Pass	45 degrees	

Crankshaft Position Sensor Stud	30 N.m	22 lb ft
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**Crankshaft Rear Oil Seal Housing Bolt**

• First Pass	15 N.m	11 lb ft
• Final Pass	50 degrees	

Cruise Control Module Bracket Retaining Nut	9 N.m	80 lb in
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**Cylinder Head Bolt**

• First Pass	50 N.m	37 lb ft
• Final Pass	120 degrees	

Drive Belt Tensioner Bolt/Nut	50 N.m	37 lb ft
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Drive Belt Tensioner Bracket Stud	17 N.m	12 lb ft
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EGR Valve Adapter to Cylinder Head Bolt/Stud	50 N.m	37 lb ft
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EGR Valve Inlet Pipe to Exhaust Manifold Bolt	29 N.m	21 lb ft
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EGR Valve Nut	29 N.m	21 lb ft
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EGR Valve Outlet Pipe Bolt/Nut	29 N.m	21 lb ft
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EGR Valve Wiring Harness Heat Shield Bolt/Nut	10 N.m	89 lb in
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Engine Block Heater	50 N.m	37 lb ft
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Engine Coolant Temperature Sensor	25 N.m	18 lb ft
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**Engine Flywheel Bolt**

• First Pass	15 N.m	11 lb ft
• Final Pass	50 degrees	

Engine Front Cover Bolt/Stud		
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• First Pass	20 N.m	15 lb ft
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• Final Pass	40 degrees	
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Engine Lift Bracket Bolt/Nut/Stud	30 N.m	22 lb ft
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Engine to Transaxle Mounting Bolt	75 N.m	55 lb ft
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Engine Wiring Harness Heat Shield Bolt/Nut	10 N.m	89 lb in
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Exhaust Manifold Bolt/Nut	30 N.m	22 lb ft
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Exhaust Manifold Heat Shield Nut	20 N.m	15 lb ft
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Exhaust Manifold Pipe Nut	40 N.m	30 lb ft
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Exhaust Manifold Stud	10 N.m	89 lb in
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Flywheel to Torque Converter Bolt	63 N.m	46 lb ft
Fuel Injector Rail Assembly Nut	10 N.m	89 lb in
Fuel Injector Rail Stud	25 N.m	18 lb ft
Fuel Injector Sight Shield Bracket Nut	30 N.m	22 lb ft
Generator Brace Bracket Bolt	50 N.m	37 lb ft
Generator Bracket Bolt	50 N.m	37 lb ft
Heated Oxygen Sensor	42 N.m	31 lb ft
Heated Inlet Pipe Nut	25 N.m	18 lb ft
Ignition Control Module Bracket Stud	17 N.m	12 lb ft
Ignition Control Module Assembly Bracket Bolt	30 N.m	22 lb ft
Ignition Control Module Assembly Bracket Nut	50 N.m	37 lb ft
Ignition Control Module Assembly Nut	8 N.m	71 lb in
Knock Sensor	18 N.m	13 lb ft
Lower Intake Manifold Bolt	15 N.m	11 lb ft
Oil Filter	30 N.m	22 lb ft
Oil Filter Adapter Bolt		
• First Pass	15 N.m	11 lb ft
• Final Pass		50 degrees
Oil Gallery Plug	30 N.m	22 lb ft
Oil Level Indicator Tube Stud/Nut	19 N.m	14 lb ft
Oil Level Sensor Bolt	20 N.m	15 lb ft
Oil Pan Bolt	14 N.m	125 lb in
Oil Pan Drain Plug	30 N.m	22 lb ft
Oil Pressure Sensor	16 N.m	12 lb ft
Oil Pump Cover Screw	11 N.m	98 lb in
Oil Pump Pipe and Screen Bolt	15 N.m	11 lb ft
Oil Filter Adapter Bolt	30 N.m	22 lb ft
Right Engine Mount Bracket Stud	8 N.m	71 lb in
Right Engine Mount Bracket to Engine	60 N.m	44 lb ft
Right Engine Mount to Bracket Nut	80 N.m	59 lb ft
Right Engine Mount to Frame Rail Nuts	70 N.m	52 lb ft
Spark Plug	15 N.m	11 lb ft
Starter Motor Heat Shield Bolt	30 N.m	22 lb ft
Throttle Body Bolt/Nut	10 N.m	89 lb in

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Throttle Body Support Bolt	16 N.m	12 lb ft
Timing Chain Dampener Bolt	22 N.m	16 lb ft
Upper Intake Manifold Bolt	10 N.m	89 lb in
Valve Lifter Guide Retainer Bolt	30 N.m	22 lb ft
Valve Rocker Arm Bolt		
• First Pass	15 N.m	11 lb ft
• Final Pass		90 degrees
Valve Rocker Arm Cover Bolt	10 N.m	89 lb in
Water Outlet Housing Bolt	27 N.m	20 lb ft
Water Pump Bolt		
• Large Bolt	34 N.m	25 lb ft
• Small Bolt	22 N.m	16 lb ft
Water Pump Pulley Bolt	13 N.m	116 lb in

## ENGINE MECHANICAL SPECIFICATIONS

### Engine Mechanical Specifications

Application	Specification	
	Metric	English
General Data		
• Engine Type		90 degrees V-6
• Displacement	3.8L	231 cu in
• RPO		L36, L67
• VIN		K, 1
• Bore	96.52 mm	3.8 in
• Stroke	86.36 mm	3.4 in
• Compression Ratio VIN K - @ 4 Compression Strokes		9.4:1
• Compression Ratio VIN 1 - @ 4 Compression Strokes		8.5:1
• Firing Order		1-6-5-4-3-2
• Spark Plug Gap	1.52 mm	0.60 in
Balance Shaft		

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• Bearing Bore Diameter - Front	51.973-51.999 mm	2.0462-2.0472 in
• Bearing Bore Diameter - Rear - In Block	47.584-47.612 mm	1.8735-1.8745 in
• Bearing Inside Diameter - Rear	38.117-38.194 mm	1.5007-1.5037 in
• Bearing Journal Diameter - Rear	38.072-38.105 mm	1.4989-1.5002 in
• Bearing Clearance - Rear	0.0127-0.1219 mm	0.0005-0.0048 in
• End Play	0.0-0.171 mm	0.0-0.0067 in
• Gear Lash	0.050-0.125 mm	0.002-0.0049 in

#### Block

• Balance Shaft Bearing Bore Diameter - Front	51.973-51.999 mm	2.0462-2.0472 in
• Balance Shaft Bearing Inside Diameter - Rear	38.118-38.194 mm	1.5007-1.5037 in
• Balance Shaft Bearing Bore Diameter - Rear, In Block	47.584-47.612 mm	1.8735-1.8745 in
• Camshaft Bearing Inside Diameter - Front and Rear	46.970-46.934 mm	1.8428-1.8492 in
• Camshaft Bearing Inside Diameter - Middle #2, #3	46.977-46.942 mm	1.8481-1.8495 in
• Crankshaft Main Bearing Bore Diameter	68.249-68.270 mm	2.6870-2.6878 in
• Cylinder Bore Diameter	98.5 mm	3.8 in
• Cylinder Bore Out-of-Round - Diametral	0.0254 mm	0.001 in
• Cylinder Bore Taper	0.0254 mm	0.001 in
• Cylinder Head Deck Height	216.459 mm	8.522 in
• Cylinder Head Deck Surface Flatness - Overall	0.0762 mm	0.003 in
• Valve Lifter Bore Diameter	21.424-21.450 mm	0.8435-0.8445 in

#### Camshaft

• Camshaft Bearing Inside Diameter - 1 and 4	46.970-46.934 mm	1.8478-1.8492 in
• Camshaft Bearing Inside Diameter - 2 and 3	46.977-46.942 mm	1.8481-1.8495 in
• Camshaft Journal Diameter	47.655-46.858 mm	1.8462-1.8448 in
• Camshaft Journal Out-of-Round	0.00635 mm	0.00025 in
• Camshaft Journal to Bearing Clearance	0.041-0.119 mm	0.0016-0.0047 in
• Camshaft Lobe Duration - Exhaust	330 Crankshaft degrees	

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• Camshaft Lobe Duration - Intake	320 Crankshaft degrees	
• Camshaft Lobe Lift - Exhaust	6.56 mm	0.258 in
• Camshaft Lobe Lift - Intake	6.56 mm	0.258 in
• Camshaft Lobe Overlap	96 Crankshaft degrees	

#### Connecting Rod

• Connecting Rod Bearing Clearance	0.0127-0.0660 mm	0.0005-0.0026 in
• Connecting Rod Bore Diameter	60.295-60.312 mm	2.37378-2.3745 in
• Connecting Rod Length - Center to Center - S/C	143.205-143.307 mm	5.638-5.642 in
• Connecting Rod Length - Center to Center - Non S/C	145.796-145.898 mm	5.740-5.744 in
• Connecting Rod Side Clearance	0.102-0.508 mm	0.004-0.0200 in

#### Crankshaft

• Connecting Rod Journal Diameter	57.1170-57.1475 mm	2.2487-2.2499 in
• Connecting Rod Journal Out-of-Round	0.00508 mm	0.00020 in
• Connecting Rod Journal Taper	0.00889 mm	0.00035 in
• Crankshaft End Play	0.076-0.276 mm	0.003-0.011 in
• Crankshaft Main Bearing Clearance - #1	0.0178-0.0406 mm	0.0007-0.0016 in
• Crankshaft Main Bearing Clearance - #2, 3 and 4	0.0229-0.0457 mm	0.0009-0.0018 in
• Crankshaft Main Journal Diameter	63.470-63.495 mm	2.4988-2.4998 in
• Crankshaft Main Journal Out-of-Round	0.00635 mm	0.00025 in
• Crankshaft Main Journal Taper	0.00889 mm	0.00035 in
• Crankshaft Rear Flange Runout	0.05 mm	0.002 in
• Crankshaft Runout - from Main 2 & 3 to 1 & 4	0.076 mm	0.003 in

#### Cylinder Head

• Combustion Chamber Depth - at Measurement Point	3.9166-5.4356 mm	0.154-0.214 in
• Cylinder Head Height/Thickness	103.492-104.178 mm	4.0745-4.1015 in

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• Surface Finish	0.0032 mm	0.000125 in
• Surface Flatness - Block Deck	0.1016 mm	0.004 in
• Surface Flatness - Exhaust Manifold Deck	0.1016 mm	0.004 in
• Surface Flatness - Intake Manifold Deck	0.1016 mm	0.004 in
• Valve Guide Bore - Exhaust	8.001-8.0213 mm	0.3150-0.3158 in
• Valve Guide Bore - Intake	8.001-8.0213 mm	0.3150-0.3158 in
<b>Exhaust Manifold</b>		
• Surface Flatness	0.5 mm	0.02 in
<b>Lubrication System</b>		
• Oil Capacity - with Filter	4.3L	4.5 qts
• Oil Capacity - without Filter	3.76L	4 qts
• Oil Pressure - @ 1850 RPM	414 kPa	60 psi
<b>Oil Pump</b>		
• Gear Pocket - Depth	11.71-11.75 mm	0.461-0.4625 in
• Gear Pocket - Diameter	89.10-89.20 mm	3.508-3.512 in
• Inner Gear Tip Clearance	0.152 mm	0.006 in
• Relief Valve-to-Bore Clearance	0.038-0.076 mm	0.0015-0.003 in
<b>Piston Ring End Gap</b>		
• First Compression Ring	0.25-0.46 mm	0.010-0.018 in
• Second Compression Ring	0.58-0.84 mm	0.023-0.033 in
• Oil Control Ring	0.254-0.762 mm	0.010-0.030 in
<b>Piston Ring to Groove Clearance</b>		
• First Compression Ring	0.033-0.079 mm	0.0013-0.0031 in
• Second Compression Ring	0.033-0.079 mm	0.0013-0.0031 in
• Oil Control Ring	0.023-0.201 mm	0.0009-0.0079 in
<b>Piston Ring Thickness</b>		
• First Compression Ring	1.176-1.197 mm	0.0463-0.0471 in
• Second Compression Ring	1.1476-1.497 mm	0.0581-0.0589 in
• Oil Control Ring	1.854-2.007 mm	0.073-0.079 in
<b>Pistons and Pins - Piston</b>		

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• Piston Diameter - Production - S/C	96.489-96.528 mm	3.7988-3.8003 in
• Piston Diameter - Production - Non S/C	96.482-96.497 mm	3.7985-3.7991 in
• Piston Diameter - Service Limit - Minimum - S/C	96.434 mm	3.7966 in
• Piston Diameter - Service Limit - Minimum - Non S/C	96.442 mm	3.7969 in
• Piston Pin Bore Diameter - S/C	23.0065-23.0105 mm	0.9058-0.9059 in
• Piston Pin Bore Diameter - Non S/C	22.0060-22.0110 mm	0.8664-0.8666 in
• Piston to Bore Clearance - New - VIN K	0.010-0.051 mm	0.0004-0.0020 in
• Piston to Bore Clearance - Used - VIN K	0.050-0.091 mm	0.0020-0.0036 in
• Piston to Bore Clearance - New - VIN 1	-0.0207-0.0437 mm	-0.0008-0.0018 in
• Piston to Bore Clearance - Used VIN 1	0.0193-0.0997 mm	0.0008-0.0039 in

### Pistons and Pins - Pin

• Piston Pin Clearance to Connecting Rod Bore - Press Fit - VIN K	0.0066-0.0217 mm	0.0003-0.0009 in
• Piston Pin Clearance to Piston Pin Bore - VIN K	0.0020-0.0130 mm	0.00008-0.00051 in
• Piston Pin Diameter - VIN K	21.9950-22.000 mm	0.8659-0.8661 in
• Piston Pin Clearance to Connecting Rod Bore - Press Fit - VIN 1	0.0073-0.0225 mm	0.00029-0.00089 in
• Piston Pin Clearance to Piston Pin Bore - VIN 1	0.0065-0.0155 mm	0.00061-0.00026 in
• Piston Pin Diameter - VIN 1	22.995-23.000 mm	0.90531-0.90551 in

### Valves

• Valve Face Angle	46 degrees	
• Valve Face Runout	0.0508 mm	0.002 in
• Valve Head Diameter - Intake	46.37-46.63 mm	1.826-1.836 in
• Valve Head Diameter - Exhaust	38.481-38.735 mm	1.515-1.525 in

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• Valve Length	119.464-119.972 mm	4.7033-4.7233 in
• Valve Seat Angle	45 degrees	
• Valve Seat Runout	0.050 mm	0.002 in
• Valve Seat Width - Intake	1.53-2.03 mm	0.060-0.080 in
• Valve Seat Width - Exhaust	2.29-2.79 mm	0.090-0.110 in
• Valve Stem Diameter	7.948-7.965 mm	0.3129-0.3136 in
• Valve Stem-to-Guide Clearance - Intake	0.031-0.071 mm	0.0012-0.0028 in
• Valve Stem-to-Guide Clearance - Exhaust	0.036-0.074 mm	0.0014-0.0029 in
<b>Valve Lifters/Push Rods</b>		
• Push Rod Length - Intake, Yellow	178.13 mm	7.013 in
• Push Rod Length - Exhaust, Green	178.13 mm	7.013 in
• Valve Lifter Diameter	21.387-21.405 mm	0.842-0.843 in
<b>Valve Rocker Arms</b>		
• Valve Rocker Arm Ratio	1.66:1	
<b>Valve Springs</b>		
• Valve Spring Free Length	49.78 mm	1.960 in
• Valve Spring Installed Height	42.93-44.45 mm	1.690-1.750 in
• Valve Spring Load - Closed	334 N @ 43.69 mm	75 lb @ 1.72 in
• Valve Spring Load - Open	1014 N @ 32.4 mm	228 lb @ 1.277 in
• Valve Spring Total Number of Coils	6.6	

### SEALERS, ADHESIVES AND LUBRICANTS

#### Sealers, Adhesives and Lubricants

Application	Type of Material	GM Part Number	
		United States	Canada
Accelerator Control Cable Bracket Bolt Threads	Threadlock	12345382	10953489
Coolant Temperature Sensor Threads	Sealant	12346004	10953480

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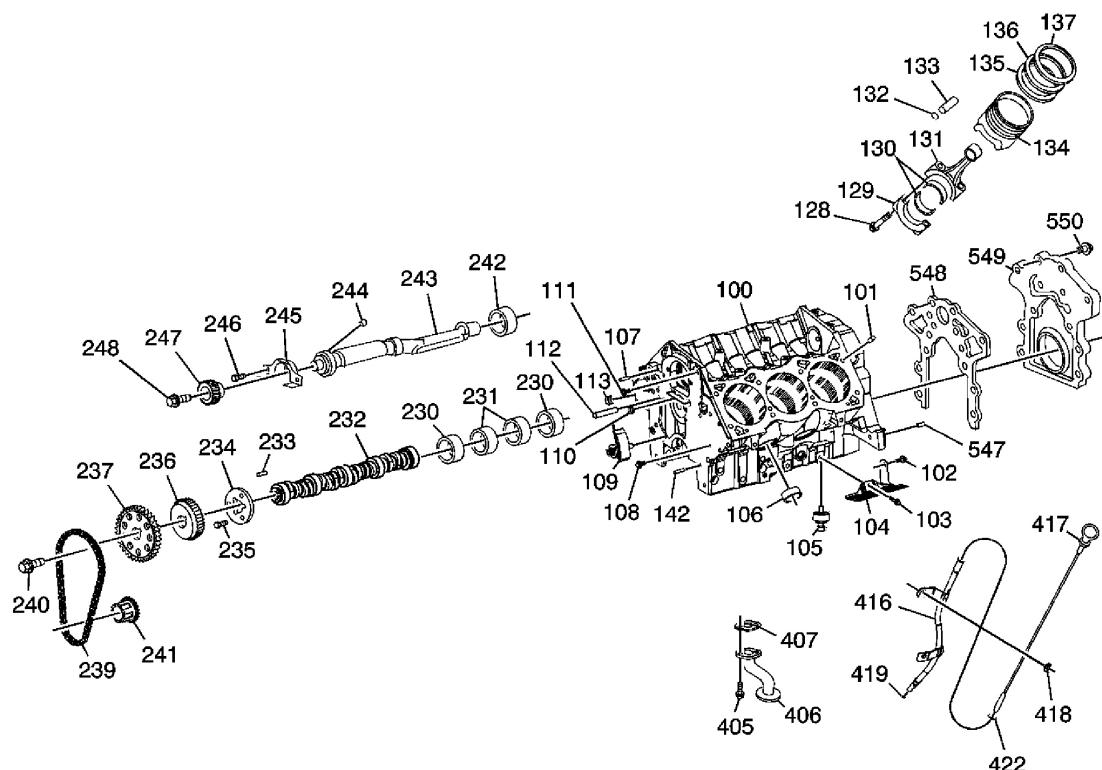
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Crankshaft Position Sensor Bolt/Stud Threads	Threadlock	12345382	10953489
Crankshaft Side Main Bolt Threads	Threadlock	12345493	10953488
Engine Block Coolant Drain Plug Threads	Sealant	12346004	10953480
Engine Block Oil Gallery Plug Threads	Sealant	12346004	10953480
Engine Front Cover Bolt Threads	Sealant	12346004	10953480
Engine Oil Supplement	Lubricant	1052367	992869
Exhaust Manifold Bolt and Stud Threads	Threadlock	12345493	10953488
Intake Manifold Bolt Threads - Lower	Threadlock	12345493	10953488
Intake Manifold Coolant Pipe	Sealant	12345493	10953488
Intake Manifold to Engine Block Mating Surface	Sealant	12378521	88901148
Knock Sensor Threads	Sealant	12346004	10953480
Oil Filter Bypass Hole Plug Threads	Sealant	12346004	10953480
Oil Pan	Sealant	12378521	88901148
Oil Pan Bolt Threads	Threadlock	12345382	10953489
Oil Pressure Switch Threads	Sealant	12346004	10953480
Piston and Piston Pin	Oil-5W-30	12345616	993182
Rear Crankshaft Main Bearing Cap	Sealant	12378521	88901148
Supercharger Oil	Lubricant	12345982	10953513
Throttle Body Stud Threads	Threadlock	12345382	10953489
Valve Lifter and Camshaft Prelube	Lubricant	12345501	992704
Valve Rocker Arm Cover Bolt Threads	Threadlock	12345382	10953489
Valve Rocker Arm Bolt Threads	Threadlock	12345493	10953488
Valve Train Component Prelube	Lubricant	1052367	992869

**COMPONENT LOCATOR****DISASSEMBLED VIEWS**

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**Fig. 1: View Of Engine Block & Components**

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Courtesy of GENERAL MOTORS CORP.

## Callouts For Fig. 1

Callout	Component Name
100	Engine Block
101	Cylinder Head Locator Pins
102	Starter Motor Heat Shield Bolt - Large
103	Starter Motor Heat Shield Bolt - Small
104	Starter Motor Heat Shield
105	Knock Sensor
106	Engine Block Expansion Plug
107	Engine Front Cover Locator Pins - Large
108	Engine Block Coolant Drain Plug
109	Timing Chain Dampener
110	Engine Block Oil Gallery Plug - Front
111	Engine Mount Strut Access Hole Plug
112	Engine Mount Strut Bracket Stud

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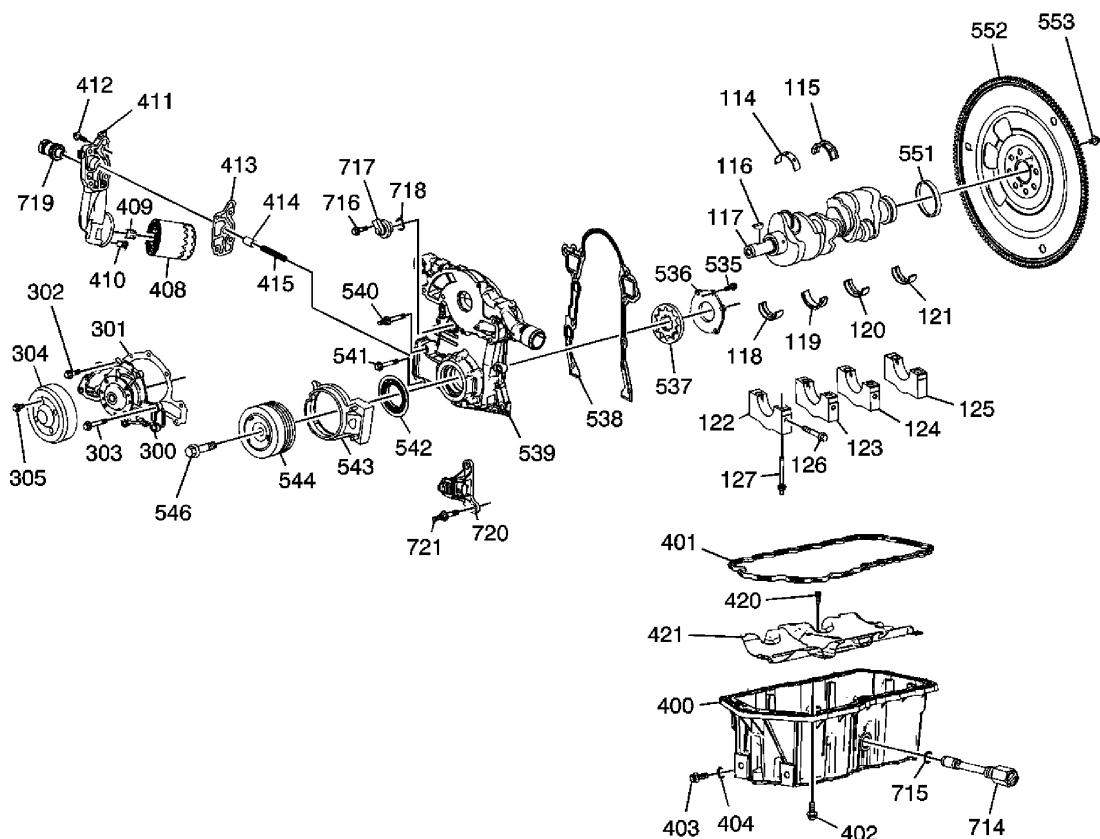
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113	Engine Block Oil Gallery Plug - Right
128	Connecting Rod Bearing Cap Bolt
129	Connecting Rod Bearing Cap
130	Connecting Rod Bearing
131	Connecting Rod
132	Piston Pin Retainer
133	Piston Pin
134	Piston
135	Piston Oil Control Ring
136	Piston Compression Ring
137	Piston Compression Ring
142	Engine Front Cover Locator Pins - Small
230	Camshaft Bearing - 1 and 4
230	Camshaft Bearing - 1 and 4
231	Camshaft Bearing - 2 and 3
232	Camshaft
233	Camshaft Key
234	Camshaft Thrust Plate
235	Camshaft Thrust Plate Bolt
236	Balance Shaft Drive Gear
237	Camshaft Sprocket
239	Timing Chain
240	Camshaft Sprocket Bolt
241	Crankshaft Sprocket
242	Balance Shaft Rear Bushing
243	Balance Shaft
244	Balance Shaft Gear Pin
245	Balance Shaft Retainer
246	Balance Shaft Retainer Bolt
247	Balance Shaft Driven Gear
248	Balance Shaft Gear Bolt
405	Oil Pump Screen Bolt
406	Oil Pump Screen
407	Oil Pump Screen Gasket
416	Oil Level Indicator Tube

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	Oil Level Indicator
418	Oil Level Indicator Tube Nut
419	Oil Level Indicator Tube Seal
422	Oil Level Indicator Seal
547	Transmission Locator Pin
548	Crankshaft Rear Oil Seal Housing Gasket
549	Crankshaft Rear Oil Seal Housing Gasket
550	Crankshaft Rear Oil Seal Housing



**Fig. 2: View Of Crankshaft & Components**  
Courtesy of GENERAL MOTORS CORP.

## Callouts For Fig. 2

Callout	Component Name
114	Crankshaft Main Bearing - Upper - 1, 3 and 4
115	Crankshaft Main Bearing - Upper - 2
116	Crankshaft Balancer Key

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117	Crankshaft
118	Crankshaft Main Bearing - Lower - 1
119	Crankshaft Main Bearing - Lower - 2
120	Crankshaft Main Bearing - Lower - 3
121	Crankshaft Main Bearing - Lower - 4
122	Crankshaft Main Bearing Cap - 1
123	Crankshaft Main Bearing Cap - 2
124	Crankshaft Main Bearing Cap - 3
125	Crankshaft Main Bearing Cap - 4
126	Crankshaft Main Bearing Cap Bolt - Side
127	Crankshaft Main Bearing Cap Bolt
300	Water Pump
301	Water Pump Gasket
302	Water Pump Bolt - Short
303	Water Pump Bolt - Long
304	Water Pump Pulley
305	Water Pump Pulley Bolt
400	Oil Pan
401	Oil Pan Gasket
402	Oil Pan Bolt
403	Oil Pan Drain Plug
404	Oil Pan Drain Plug Seal
408	Oil Filter
409	Oil Filter Fitting
410	Oil Filter Bypass Valve
411	Oil Filter Adapter
412	Oil Filter Adapter Bolt
413	Oil Filter Adapter Gasket
414	Oil Pressure Relief Valve
415	Oil Pressure Relief Valve Spring
420	Oil Pan Baffle Bolt
421	Oil Pan Baffle
535	Oil Pump Cover Bolt
536	Oil Pump Cover
537	Oil Pump Gear Set

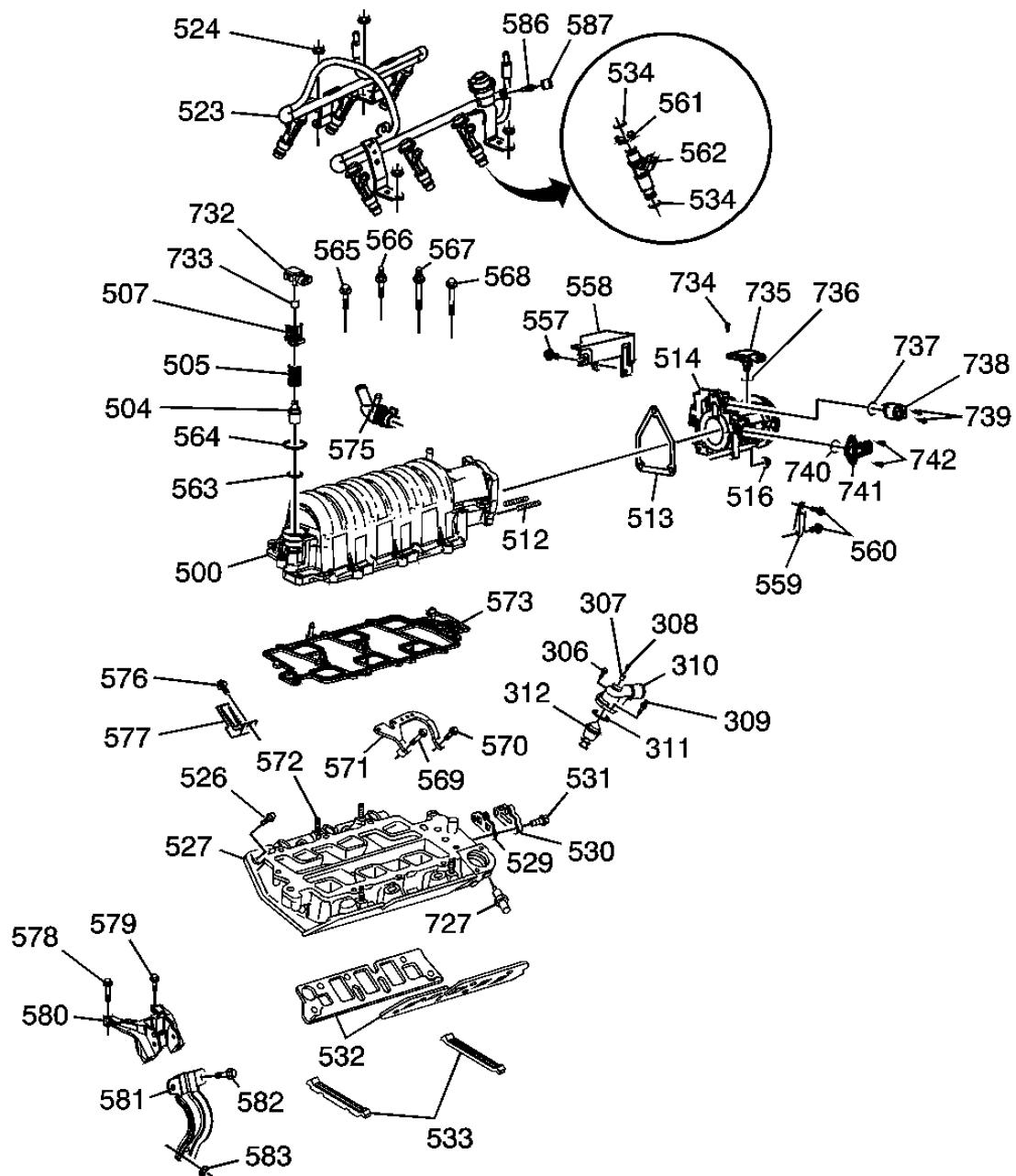
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	Engine Front Cover Gasket
539	Engine Front Cover
540	Engine Front Cover Stud
541	Engine Front Cover Bolt
542	Crankshaft Front Oil Seal
543	Crankshaft Position Sensor Shield
544	Crankshaft Balancer
546	Crankshaft Balancer Bolt
551	Crankshaft Rear Oil Seal
552	Flywheel
553	Flywheel Bolt
714	Oil Level Indicator Sensor
715	Oil Level Indicator Switch Seal
716	Camshaft Position Sensor Bolt
717	Camshaft Position Sensor
718	Camshaft Position Sensor Seal
719	Engine Oil Pressure Indicator Sensor
720	Crankshaft Position Sensor
721	Crankshaft Position Sensor Stud

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**Fig. 3: Identifying Intake Manifold & Components**  
 Courtesy of GENERAL MOTORS CORP.

### Callouts For Fig. 3

Callout	Component Name
306	Water Outlet Housing Bolt
307	Coolant Bleed Valve Fitting

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308	Coolant Bleed Valve
309	Water Outlet Housing Stud
310	Water Outlet Housing
311	Thermostat Seal
312	Thermostat
500	Intake Manifold - Upper
504	PCV Valve
505	PCV Valve Spring
507	PCV Valve Retainer
512	Throttle Body Stud
513	Throttle Body Gasket
514	Throttle Body
516	Throttle Body Nut
523	Fuel Rail
524	Fuel Rail Nut
526	Intake Manifold Bolt
527	Intake Manifold - Lower
529	Engine Coolant Manifold Gasket
530	Engine Coolant Manifold
531	Engine Coolant Manifold Bolt
532	Intake Manifold Gasket - Lower
533	Intake Manifold Seal - Lower
534	Fuel Injector Seal
534	Fuel Injector Seal
557	Throttle Cable Bracket Bolt
558	Throttle Cable Bracket
559	Throttle Body Support Bracket
560	Throttle Body Support Bracket Bolt
561	Fuel Injector Retaining Clip
562	Fuel Injector
563	PCV Valve Seal - Small
564	PCV Valve Seal - Large
565	Intake Manifold Bolt - Upper - Short
566	Intake Manifold Stud - Upper - Short
567	Intake Manifold Stud - Upper - Long

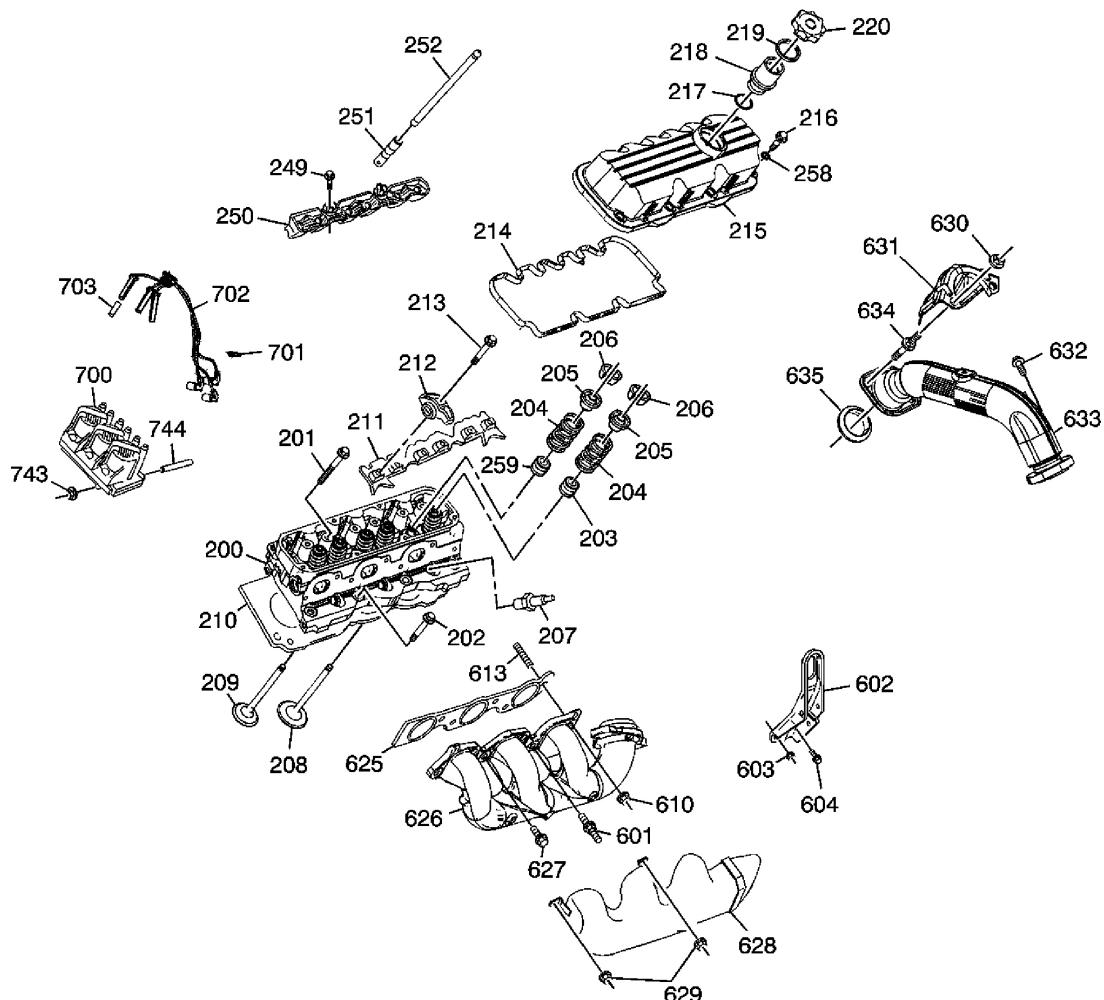
**2006 Buick Lucerne CXS**

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	Intake Manifold Bolt - Upper - Long
569	Generator Brace Bracket Bolt - Long
570	Generator Brace Bracket Bolt - Short
571	Generator Brace Bracket
572	Intake Manifold Stud - Lower
573	Intake Manifold Gasket - Upper
575	Vacuum Manifold
576	EVAP Purge Valve Bracket Bolt
577	EVAP Purge Valve Bracket
578	Engine Mounting Strut Bracket Bolt - Upper - Long
579	Engine Mounting Strut Bracket Bolt - Upper - Short
580	Engine Mounting Strut Bracket - Upper
581	Engine Mounting Strut Bracket - Lower
582	Engine Mounting Strut Bracket Bolt - Lower
583	Engine Mounting Strut Bracket Nut - Lower
586	Fuel Schrader Valve
587	Fuel Service Port
727	Engine Coolant Temperature Sensor
732	MAP Sensor
733	MAP Sensor Seal
734	MAF Sensor Bolt
735	MAF Sensor
736	MAF Sensor Seal
737	IAC Sensor Seal
738	IAC Sensor
739	IAC Sensor Bolt
740	TPS Sensor Seal
741	TPS Sensor
742	TPS Sensor Bolt

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**Fig. 4: Identifying Left Cylinder Head & Components - L36**  
Courtesy of GENERAL MOTORS CORP.

## Callouts For Fig. 4

Callout	Component Name
200	Cylinder Head
201	Cylinder Head Bolt - Long
202	Cylinder Head Bolt - Short
203	Valve Seal - Exhaust
204	Valve Spring
204	Valve Spring
205	Valve Stem Cap
205	Valve Stem Cap

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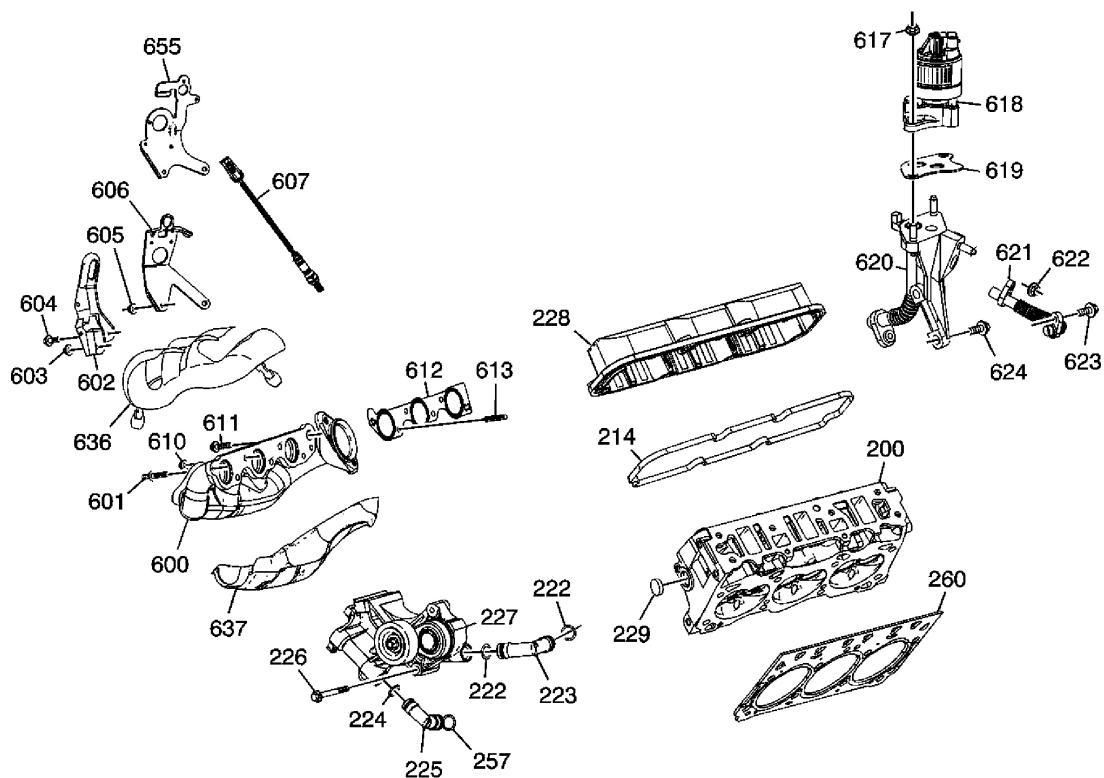
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206	Valve Stem Key
206	Valve Stem Key
207	Spark Plug
208	Exhaust Valve
209	Intake Valve
210	Cylinder Head Gasket - LH
211	Valve Rocker Arm Retainer
212	Valve Rocker Arm
213	Valve Rocker Arm Bolt
214	Valve Rocker Arm Cover Gasket
215	Valve Rocker Arm Cover - LH
216	Valve Rocker Arm Cover Bolt
217	Oil Fill Tube Seal
218	Oil Fill Tube
219	Oil Fill Cap Seal
220	Oil Fill Cap
249	Valve Lifter Guide Bolt
250	Valve Lifter Guide
251	Valve Lifter
252	Pushrod
258	Valve Rocker Arm Cover Bolt Seal
259	Valve Seal - Intake
601	Exhaust Manifold Stud
602	Engine Lift Bracket
603	Engine Lift Bracket Nut
604	Engine Lift Bracket Bolt
610	Exhaust Manifold Nut
613	Exhaust Manifold Stud - to Cylinder Head
625	Exhaust Manifold Gasket - Left
626	Exhaust Manifold - Left
627	Exhaust Manifold Bolt - Left
628	Exhaust Manifold Heat Shield - Left
629	Exhaust Manifold Heat Shield Nut - Left
630	Power Brake Booster Heat Shield Nut
631	Power Brake Booster Heat Shield

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	Exhaust Crossover Pipe Bolt
633	Exhaust Crossover Pipe
634	Exhaust Crossover Pipe Stud
635	Exhaust Crossover Pipe Seal
700	Electronic Ignition Module
701	Spark Plug Wire Harness Clip
702	Spark Plug Wire Harness
703	Spark Plug Wire Heat Shield
743	Electronic Ignition Module Nut
744	Electronic Ignition Module Stud



**Fig. 5: Identifying Right Cylinder Head & Components**  
 Courtesy of GENERAL MOTORS CORP.

#### Callouts For Fig. 5

Callout	Component Name
200	Cylinder Head
214	Valve Rocker Arm Cover Gasket

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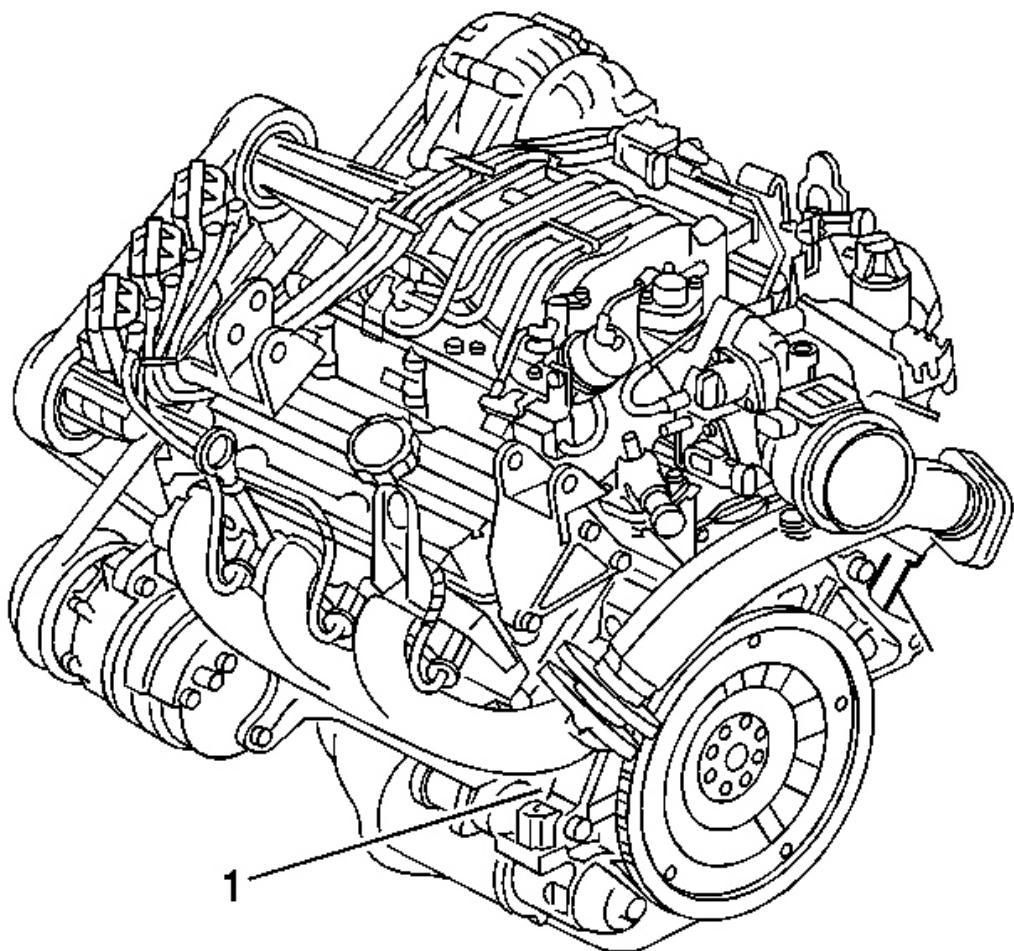
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222	Thermostat Bypass Pipe Seal - Upper
222	Thermostat Bypass Pipe Seal - Upper
223	Thermostat Bypass Pipe - Upper
224	Thermostat Bypass Pipe Seal - Lower - Small
225	Thermostat Bypass Pipe - Lower
226	Drive Belt Tensioner Bolt
227	Drive Belt Tensioner
228	Valve Rocker Arm Cover - RH
229	Cylinder Head Expansion Plug
257	Thermostat Bypass Pipe Seal - Lower - Large
260	Cylinder Head Gasket - RH
600	Exhaust Manifold - Right
601	Exhaust Manifold Stud
602	Engine Lift Bracket
603	Engine Lift Bracket Nut
604	Engine Lift Bracket Bolt
605	Engine Sight Shield Bracket - Nut
606	Engine Sight Shield Bracket - L36
607	Heated Oxygen Sensor
610	Exhaust Manifold Nut
611	EGR Valve Adapter Pipe Bolt - to Exhaust Manifold
612	Exhaust Manifold Gasket - Right
613	Exhaust Manifold Stud - to Cylinder Head
617	EGR Valve Nut
618	EGR Valve
619	EGR Valve Gasket
620	EGR Valve Adapter
621	EGR Valve Outlet Pipe
622	EGR Valve Outlet Pipe Nut
623	EGR Valve Outlet Pipe Bolt
624	EGR Valve Adapter Pipe Bolt - to Cylinder Head
636	Exhaust Manifold Heat Shield - Right - Upper
637	Exhaust Manifold Heat Shield - Right - Lower
655	Engine Sight Shield Bracket - L67

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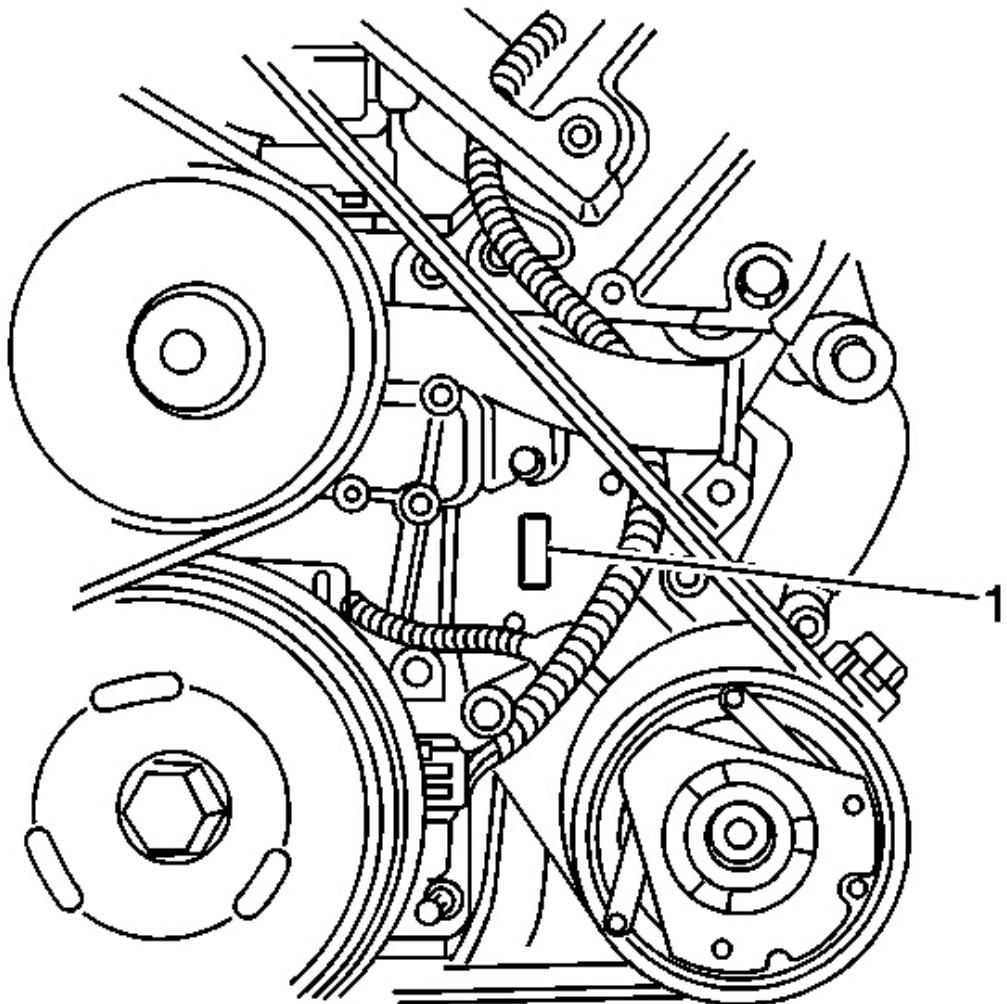
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### ENGINE IDENTIFICATION



**Fig. 6: Locating Primary Vehicle Identification Number - VIN**  
Courtesy of GENERAL MOTORS CORP.

The primary Vehicle Identification Number - VIN derivative for the 3800 - L36 and 3800 - L67 is stamped or laser etched on the left side of the engine block above the starter motor (1).



**Fig. 7: Locating Secondary Vehicle Identification Number - VIN**  
Courtesy of GENERAL MOTORS CORP.

The secondary Vehicle Identification Number - VIN, derivative for the 3800 - L36 and 3800 - L67 is stamped or laser etched below the water pump on the engine block (1). The Vehicle Identification Number - derivative is nine digits long and can be used to determine if a vehicle contains the original engine.

- The first digit identifies the division.
- The second digit identifies the model year.

- The third digit identifies the assembly plant.
- The fourth through ninth digit are the last six of the Vehicle Identification Number - VIN.

## **DIAGNOSTIC INFORMATION AND PROCEDURES**

### **DIAGNOSTIC STARTING POINT - ENGINE MECHANICAL**

Begin the system diagnosis by reviewing the **Disassembled Views**, **Engine Component Description**, **Drive Belt System Description**, **Lubrication Description** and **New Product Information**. Reviewing the description and operation information will help you determine the correct symptom diagnostic procedure when a malfunction exists. Reviewing the description and operation information will also help you determine if the condition described by the customer is normal operation. Refer to **Symptoms - Engine Mechanical** in order to identify the correct procedure for diagnosing the system and where the procedure is located.

### **SYMPTOMS - ENGINE MECHANICAL**

#### **Strategy Based Diagnostics**

1. Perform A Diagnostic System Check in Engine Controls before using the symptom tables, if applicable.
2. Review the system operations in order to familiarize yourself with the system functions. Refer to **Disassembled Views**, **Engine Component Description**, **Drive Belt System Description**, **Lubrication Description** and **New Product Information**.

All diagnosis on a vehicle should follow a logical process. Strategy based diagnostics is a uniform approach for repairing all systems. The diagnostic flow may always be used in order to resolve a system problem. The diagnostic flow is the place to start when repairs are necessary. For a detailed explanation, refer to **Strategy Based Diagnosis** in General Information.

#### **Visual/Physical Inspection**

- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Check for the correct oil level, proper oil viscosity and correct filter application.
- Verify the exact operating conditions under which the concern exists. Note factors such as engine RPM, ambient temperature, engine temperature, amount of engine warm-up time and other specifics.
- Compare the engine sounds, if applicable to a known good engine and make sure you are not trying to correct a normal condition.

## Intermittent

Test the vehicle under the same conditions that the customer reported in order to verify the system is operating properly.

## Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- [Base Engine Misfire without Internal Engine Noises](#)
- [Base Engine Misfire with Abnormal Internal Lower Engine Noises](#)
- [Base Engine Misfire with Abnormal Valve Train Noise](#)
- [Base Engine Misfire with Coolant Consumption](#)
- [Base Engine Misfire with Excessive Oil Consumption](#)
- [Engine Compression Test](#)
- [Engine Noise on Start-Up, but Only Lasting a Few Seconds](#)
- [Upper Engine Noise, Regardless of Engine Speed](#)
- [Lower Engine Noise, Regardless of Engine Speed](#)
- [Engine Noise Under Load](#)
- [Engine Will Not Crank - Crankshaft Will Not Rotate](#)
- [Oil Consumption Diagnosis](#)
- [Oil Pressure Diagnosis and Testing](#)
- [Oil Leak Diagnosis](#)
- [Drive Belt Chirping Diagnosis](#)
- [Drive Belt Squeal Diagnosis](#)
- [Drive Belt Whine Diagnosis](#)
- [Drive Belt Rumbling Diagnosis](#)
- [Drive Belt Vibration Diagnosis](#)
- [Drive Belt Falls Off Diagnosis](#)
- [Drive Belt Excessive Wear Diagnosis](#)
- [Drive Belt Tensioner Diagnosis](#)

## BASE ENGINE MISFIRE WITHOUT INTERNAL ENGINE NOISES

### Base Engine Misfire without Internal Engine Noises

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Cause	Correction
Abnormalities, severe cracking, bumps or missing areas in the accessory drive belt Abnormalities in the accessory drive system and/or components may cause engine RPM variations and lead to a misfire DTC. A misfire code may be present without an actual misfire condition.	Replace the drive belt. Refer to <a href="#"><b>Drive Belt Replacement</b></a> .
Worn, damaged or mis-aligned accessory drive components or excessive pulley runout may lead to a misfire DTC. A misfire code may be present without an actual misfire condition.	Inspect the components and repair or replace as required.
Loose or improperly installed engine flywheel or crankshaft balancer A misfire code may be present without an actual misfire condition.	Repair or replace the flywheel and/or balancer as required. Refer to <a href="#"><b>Engine Flywheel Replacement</b></a> or <a href="#"><b>Crankshaft Balancer Replacement</b></a> .
Restricted exhaust system A severe restriction in the exhaust flow can cause significant loss of engine performance and may set a DTC. Possible causes of restrictions include collapsed or dented pipes or plugged mufflers and/or catalytic converters.	Repair or replace as required.
Improperly installed or damaged vacuum hoses	Repair or replace as required.
Improper sealing between the intake manifold and cylinder heads or throttle body.	Replace the intake manifold, gaskets, cylinder heads, and/or throttle body as required.
Worn or loose rocker arms The rocker arm bearing end caps and/or needle bearings should be intact and in the proper position	Replace the valve rocker arms as required.
Worn or bent pushrods	Replace the pushrods.
Stuck valves Carbon buildup on the valve stem can cause the valve not to close properly.	Repair or replace as required.
Excessively worn or mis-aligned timing chain	Replace the timing chain and sprockets as required.

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Worn camshaft lobes	Replace the camshaft and valve lifters.
Excessive oil pressure A lubrication system with excessive oil pressure may lead to excessive valve lifter pump-up and loss of compression.	<ul style="list-style-type: none"> <li>Perform an oil pressure test. Refer to <a href="#"><u>Oil Pressure Diagnosis and Testing</u></a>.</li> <li>Repair or replace the oil pump as required.</li> </ul>
Faulty cylinder head gaskets and/or cracking or other damage to the cylinder heads and engine block cooling system passages. Refer to <a href="#"><u>Diagnostic Starting Point - Engine Cooling</u></a> . Coolant consumption may or may not cause the engine to overheat.	<ul style="list-style-type: none"> <li>Inspect for spark plugs saturated by coolant. Refer to <a href="#"><u>Spark Plug Inspection</u></a>.</li> <li>Inspect the cylinder heads, engine block, and/or head gaskets.</li> <li>Repair or replace as required.</li> </ul>
Worn Piston Rings Oil consumption may or may not cause the engine to misfire.	<ul style="list-style-type: none"> <li>Inspect the spark plugs for oil deposits. Refer to <a href="#"><u>Spark Plug Inspection</u></a>.</li> <li>Inspect the cylinders for a loss of compression. Refer to <a href="#"><u>Engine Compression Test</u></a>.</li> <li>Perform cylinder leak down and compression testing to identify the cause.</li> <li>Repair or replace as required.</li> </ul>

### BASE ENGINE MISFIRE WITH ABNORMAL INTERNAL LOWER ENGINE NOISES

#### Base Engine Misfire with Abnormal Internal Lower Engine Noises

Cause	Correction
Abnormalities, severe cracking, bumps or missing areas, in the accessory drive belt Abnormalities in the accessory drive system and/or components may cause engine RPM variations, noises similar to a faulty lower engine and also lead to a misfire condition. A misfire code may be present without an actual misfire condition.	Replace the drive belt. Refer to <a href="#"><u>Drive Belt Replacement</u></a> .
Worn, damaged or mis-aligned accessory drive components or excessive pulley runout A misfire code may be present without an	Inspect the components, repair or replace as required.

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<p>actual misfire condition.</p> <p>Loose or improperly installed engine flywheel or crankshaft balancer</p> <p>A misfire code may be present without an actual misfire condition.</p>	<p>Repair or replace the flywheel and/or balancer as required.</p> <p>Refer to <a href="#"><u>Engine Flywheel Replacement</u></a> or <a href="#"><u>Crankshaft Balancer Replacement</u></a>.</p>
<p>Worn Piston Rings</p> <p>Oil consumption may or may not cause the engine to misfire.</p>	<ul style="list-style-type: none"> <li>• Inspect the spark plugs for oil deposits. Refer to <a href="#"><u>Spark Plug Inspection</u></a> .</li> <li>• Inspect the cylinders for a loss of compression. Refer to <a href="#"><u>Engine Compression Test</u></a>.</li> <li>• Perform cylinder leak down and compression testing to determine the cause.</li> <li>• Repair or replace as required.</li> </ul>
<p>Worn Crankshaft Thrust Bearings</p> <p>Severely worn thrust surfaces on the crankshaft and/or thrust bearing may permit fore and aft movement of the crankshaft and create a DTC without an actual misfire condition.</p>	<p>Replace the crankshaft and bearings as required.</p>

### **BASE ENGINE MISFIRE WITH ABNORMAL VALVE TRAIN NOISE**

#### **Base Engine Misfire with Abnormal Valve Train Noise**

Cause	Correction
Worn or loose rocker arms The rocker arm bearing end caps and/or needle bearings should intact within the rocker arm assembly.	Replace the valve rocker arms as required.
Worn or bent pushrods	Replace the pushrods.
Stuck valves Carbon buildup on the valve stem can cause the valve not to close properly.	Repair or replace as required.
Excessively worn or mis-aligned timing chain	Replace the timing chain and sprockets as required.
Worn camshaft lobes	Replace the camshaft and valve lifters.
Sticking lifters	Replace as required.

**BASE ENGINE MISFIRE WITH COOLANT CONSUMPTION****Base Engine Misfire with Coolant Consumption**

Cause	Correction
<p>Faulty cylinder head gaskets and/or cracking or other damage to the cylinder heads and engine block cooling system passages. Refer to <a href="#"><u>Diagnostic Starting Point - Engine Cooling</u></a>.</p> <p>Coolant consumption may or may not cause the engine to overheat.</p>	<ul style="list-style-type: none"> <li>Inspect for spark plugs saturated by coolant. Refer to <a href="#"><u>Spark Plug Inspection</u></a>.</li> <li>Perform a cylinder leak down test.</li> <li>Inspect the cylinder heads and engine block for damage to the coolant passages and/or a faulty head gasket.</li> <li>Repair or replace as required.</li> </ul>

**BASE ENGINE MISFIRE WITH EXCESSIVE OIL CONSUMPTION****Base Engine Misfire with Excessive Oil Consumption**

Cause	Correction
Worn valves, valve guides and/or valve stem oil seals	<ul style="list-style-type: none"> <li>Inspect the spark plugs for oil deposits. Refer to <a href="#"><u>Spark Plug Inspection</u></a>.</li> <li>Repair or replace as required.</li> </ul>
<p>Worn Piston Rings</p> <p>Oil consumption may or may not cause the engine to misfire.</p>	<ul style="list-style-type: none"> <li>Inspect the spark plugs for oil deposits. Refer to <a href="#"><u>Spark Plug Inspection</u></a>.</li> <li>Inspect the cylinders for a loss of compression. Refer to <a href="#"><u>Engine Compression Test</u></a>.</li> <li>Perform cylinder leak down and compression testing to determine the cause.</li> <li>Repair or replace as required.</li> </ul>

**ENGINE NOISE ON START-UP, BUT ONLY LASTING A FEW SECONDS****Engine Noise on Start-Up, but Only Lasting a Few Seconds**

Cause	Correction
Incorrect oil filter without anti-drainback feature	Install the correct oil filter.
Incorrect oil viscosity	

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	<ol style="list-style-type: none"><li>1. Drain the oil.</li><li>2. Install the correct viscosity oil.</li></ol>
Worn crankshaft thrust bearing	<ul style="list-style-type: none"><li>• Inspect the thrust bearing and crankshaft.</li><li>• Repair or replace as required.</li></ul>
High valve lifter leak down rate	Replace the lifters as required.

### UPPER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

#### Upper Engine Noise, Regardless of Engine Speed

Cause	Correction
Low oil pressure	<ul style="list-style-type: none"><li>• Perform an oil pressure test. Refer <a href="#"><u>Oil Pressure Diagnosis and Testing</u></a>.</li><li>• Repair or replace as required.</li></ul>
Loose and/or worn valve rocker arm attachments	<ul style="list-style-type: none"><li>• Inspect the valve rocker arm stud, nut or bolt.</li><li>• Repair or replace as required.</li></ul>
Worn valve rocker arm	Replace the valve rocker arm.
Bent or damaged push rod	Inspect the following components and replace as required: <ul style="list-style-type: none"><li>• The valve rocker arm</li><li>• The valve push rod</li><li>• The valve lifter</li></ul>
Improper lubrication to the valve rocker arms	Inspect the following components and repair or replace as required: <ul style="list-style-type: none"><li>• The valve rocker arm</li><li>• The valve push rod</li><li>• The valve lifter</li><li>• The oil filter bypass valve</li><li>• The oil pump and pump screen</li><li>• The engine block oil galleries</li></ul>
Broken valve spring	Replace the valve spring.
Worn and/or damaged valve rotators	Replace the valve rotators as required.

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Worn or dirty valve lifters	Replace the valve lifters.
Stretched or broken timing chain and/or damaged sprocket teeth	Replace the timing chain and sprockets.
Worn timing chain tensioner, if applicable	Replace the timing chain tensioners as required.
Worn engine camshaft lobes	<ul style="list-style-type: none"> <li>• Inspect the engine camshaft lobes.</li> <li>• Replace the camshaft and valve lifters as required.</li> </ul>
Damaged, broken or dirty, balance shaft sprocket teeth, if applicable	<p>Inspect the following components and repair as required:</p> <ul style="list-style-type: none"> <li>• The balance shaft gear</li> <li>• The camshaft gear</li> <li>• The balance shaft rear bushing</li> </ul>
Worn valve guides or valve stems	<p>Inspect the following components and repair as required:</p> <ul style="list-style-type: none"> <li>• The valves</li> <li>• The valve guides</li> </ul>
Stuck Valves Carbon on the valve stem or valve seat may cause the valve to stay open	<p>Inspect the following components and repair as required:</p> <ul style="list-style-type: none"> <li>• The valves</li> <li>• The valve guides</li> </ul>

### LOWER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

#### Lower Engine Noise, Regardless of Engine Speed

Cause	Correction
Low oil pressure	<ul style="list-style-type: none"> <li>• Perform an oil pressure test. Refer to <a href="#"><u><b>Oil Pressure Diagnosis and Testing</b></u></a>.</li> <li>• Repair or replace damaged components as required.</li> </ul>
Worn accessory drive components Abnormalities such as severe cracking, bumps or missing areas in the accessory drive belt and/or misalignment of system components.	<ul style="list-style-type: none"> <li>• Inspect the accessory drive system.</li> <li>• Repair or replace as required.</li> </ul>

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Loose or damaged crankshaft balancer	<ul style="list-style-type: none"> <li>• Inspect the crankshaft balancer.</li> <li>• Repair or replace as required.</li> </ul>
Detonation or spark knock	Verify the correct operation of the Knock Sensor System. Refer to <b><u>Electronic Ignition (EI) System Diagnosis</u></b> .
Loose torque converter bolts	<ul style="list-style-type: none"> <li>• Inspect the torque converter bolts and flywheel.</li> <li>• Repair or replace as required.</li> </ul>
Loose or damaged flywheel	Repair or replace the flywheel.
Damaged oil pan, contacting the oil pump screen  An oil pan that has been damaged may improperly position the oil pump screen, preventing proper oil flow to the oil pump.	<ul style="list-style-type: none"> <li>• Inspect the oil pan.</li> <li>• Inspect the oil pump screen</li> <li>• Repair or replace as required.</li> </ul>
Oil pump screen loose, damaged or restricted	<ul style="list-style-type: none"> <li>• Inspect the oil pump screen.</li> <li>• Repair or replace as required.</li> </ul>
Excessive piston-to-cylinder bore clearance	<ul style="list-style-type: none"> <li>• Inspect the piston and cylinder bore.</li> <li>• Repair as required.</li> </ul>
Excessive piston pin-to-bore clearance	<ul style="list-style-type: none"> <li>• Inspect the piston, piston pin and the connecting rod.</li> <li>• Repair or replace as required.</li> </ul>
Excessive connecting rod bearing clearance	<p>Inspect the following components and repair as required:</p> <ul style="list-style-type: none"> <li>• The connecting rod bearings</li> <li>• The connecting rods</li> <li>• The crankshaft</li> <li>• The crankshaft journals</li> </ul>
Excessive crankshaft bearing clearance	<p>Inspect the following components and repair as required:</p> <ul style="list-style-type: none"> <li>• The crankshaft bearings</li> <li>• The crankshaft journals</li> </ul>
Incorrect piston, piston pin and connecting rod installation	<ul style="list-style-type: none"> <li>• Verify the pistons, piston pins and connecting rods are installed correctly.</li> </ul>

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Pistons must be installed with the mark or dimple on the top of the piston facing the front of the engine. Piston pins must be centered in the connecting rod pin bore.

- Repair as required.

## ENGINE NOISE UNDER LOAD

### Engine Noise Under Load

Cause	Correction
Low oil pressure	<ul style="list-style-type: none"><li>• Perform an oil pressure test. Refer to <a href="#"><u>Oil Pressure Diagnosis and Testing</u></a>.</li><li>• Repair or replace as required.</li></ul>
Detonation or spark knock	Verify the correct operation of the Knock Sensor System. Refer to <a href="#"><u>Electronic Ignition (EI) System Diagnosis</u></a> .
Loose torque converter bolts	<ul style="list-style-type: none"><li>• Inspect the torque converter bolts and flywheel.</li><li>• Repair as required.</li></ul>
Cracked flywheel, automatic transmission	<ul style="list-style-type: none"><li>• Inspect the flywheel bolts and flywheel.</li><li>• Repair as required.</li></ul>
Excessive connecting rod bearing clearance	Inspect the following components and repair as required: <ul style="list-style-type: none"><li>• The connecting rod bearings</li><li>• The connecting rods</li><li>• The crankshaft</li></ul>
Excessive crankshaft bearing clearance	Inspect the following components and repair as required: <ul style="list-style-type: none"><li>• The crankshaft bearings</li><li>• The crankshaft journals</li><li>• The cylinder block crankshaft bearing bore</li></ul>

## ENGINE WILL NOT CRANK - CRANKSHAFT WILL NOT ROTATE

### Engine Will Not Crank - Crankshaft Will Not Rotate

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Cause	Correction
Seized accessory drive system component	<ol style="list-style-type: none"><li>1. Remove accessory drive belt or belts.</li><li>2. Rotate crankshaft by hand at the balancer or flywheel location.</li></ol>
<p>Hydraulically locked cylinder</p> <ul style="list-style-type: none"><li>• Coolant/antifreeze in cylinder</li><li>• Oil in cylinder</li><li>• Fuel in cylinder</li></ul>	<ol style="list-style-type: none"><li>1. Remove spark plugs and check for fluid.</li><li>2. Inspect for broken head gasket or gaskets.</li><li>3. Inspect for cracked engine block or cylinder head.</li><li>4. Inspect for a sticking fuel injector and/or leaking fuel regulator.</li></ol>
Seized automatic transmission torque converter	<ol style="list-style-type: none"><li>1. Remove the torque converter bolts.</li><li>2. Rotate crankshaft by hand at the balancer or flywheel location.</li></ol>
Broken timing chain and/or timing chain gears	<ol style="list-style-type: none"><li>1. Inspect timing chain and gears.</li><li>2. Repair as required.</li></ol>
Seized balance shaft bearing if equipped	<ol style="list-style-type: none"><li>1. Inspect balance shaft bearings.</li><li>2. Repair as required.</li></ol>
<p>Material in cylinder</p> <ul style="list-style-type: none"><li>• Broken valve</li><li>• Piston material</li><li>• Foreign material</li></ul>	<ol style="list-style-type: none"><li>1. Inspect cylinder for damaged components and/or foreign materials.</li><li>2. Repair or replace as required.</li></ol>
Seized crankshaft or connecting rod bearings	<ol style="list-style-type: none"><li>1. Inspect crankshaft and connecting rod bearings.</li><li>2. Repair as required.</li></ol>
Bent or broken connecting rod	<ol style="list-style-type: none"><li>1. Inspect connecting rods.</li><li>2. Repair as required.</li></ol>
Broken crankshaft	<ol style="list-style-type: none"><li>1. Inspect crankshaft.</li><li>2. Repair as required.</li></ol>

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### Coolant in Combustion Chamber

Cause	Correction
DEFINITION: Excessive white smoke and/or coolant type odor coming from the exhaust pipe may indicate coolant in the combustion chamber. Low coolant levels, an inoperative cooling fan or a faulty thermostat may lead to an overtemperature condition which may cause engine component damage.	
<ul style="list-style-type: none"><li>• A slower than normal cranking speed may indicate coolant entering the combustion chamber. Refer to <a href="#"><b>Engine Will Not Crank - Crankshaft Will Not Rotate</b></a>.</li><li>• Remove the spark plugs and inspect for spark plugs saturated by coolant or coolant in the cylinder bore.</li><li>• Inspect by performing a <a href="#"><b>Cylinder Leakage Test</b></a>. During this test, excessive air bubbles within the coolant may indicate a faulty gasket or damaged component.</li><li>• Inspect by performing a cylinder compression test. Two cylinders side-by-side on the engine block, with low compression, may indicate a failed cylinder head gasket. Refer to <a href="#"><b>Engine Compression Test</b></a>.</li></ul>	
Cracked intake manifold or failed gasket	Replace the components as required.
Faulty cylinder head gasket	Replace the head gasket and components as required. Refer to <a href="#"><b>Cylinder Head Cleaning and Inspection</b></a> and <a href="#"><b>Cylinder Head Replacement - Left Side</b></a> or <a href="#"><b>Cylinder Head Replacement - Right Side</b></a> .
Warped cylinder head	Machine the cylinder head to the proper flatness, if applicable and replace the cylinder head gasket. Refer to <a href="#"><b>Cylinder Head Replacement - Left Side</b></a> or <a href="#"><b>Cylinder Head Replacement - Right Side</b></a> .
Cracked cylinder head	Replace the cylinder head and gasket.
Cracked cylinder liner or engine block	Replace the components as required.
Cylinder head or engine block porosity	Replace the components as required.

### COOLANT IN ENGINE OIL

#### Coolant in Engine Oil

Cause	Correction
DEFINITION: Foamy or discolored oil or an engine oil overfill condition may indicate coolant entering the engine crankcase. Low coolant levels, an inoperative cooling fan or a faulty thermostat may lead to an overtemperature condition which may cause engine	

component damage. Contaminated engine oil and oil filter should be changed.

- Inspect the oil for excessive foaming or an overfill condition. Oil diluted by coolant may not properly lubricate the crankshaft bearings and may lead to component damage. Refer to [Lower Engine Noise, Regardless of Engine Speed](#).
- Inspect by performing a [Cylinder Leakage Test](#). During this test, excessive air bubbles within the cooling system may indicate a faulty gasket or damaged component.
- Inspect by performing a cylinder compression test. Two cylinders side-by-side on the engine block with low compression may indicate a failed cylinder head gasket. Refer to [Engine Compression Test](#).

Faulty external engine oil cooler	Replace the components as required.
Faulty cylinder head gasket	Replace the head gasket and components as required. Refer to <u><a href="#">Cylinder Head Cleaning and Inspection</a></u> and <u><a href="#">Cylinder Head Replacement - Left Side</a></u> or <u><a href="#">Cylinder Head Replacement - Right Side</a></u> .
Warped cylinder head	Machine the cylinder head to proper flatness, if applicable and replace the cylinder head gasket. Refer to <u><a href="#">Cylinder Head Replacement - Left Side</a></u> or <u><a href="#">Cylinder Head Replacement - Right Side</a></u> .
Cracked cylinder head	Replace the cylinder head and gasket.
Cracked cylinder liner or engine block	Replace the components as required.
Cylinder head, block or manifold porosity	Replace the components as required.

## ENGINE COMPRESSION TEST

### Tools Required

**J 38722** Compression Tester. See [Special Tools](#).

A compression pressure test of the engine cylinders determines the condition of the rings, the valves and the head gasket.

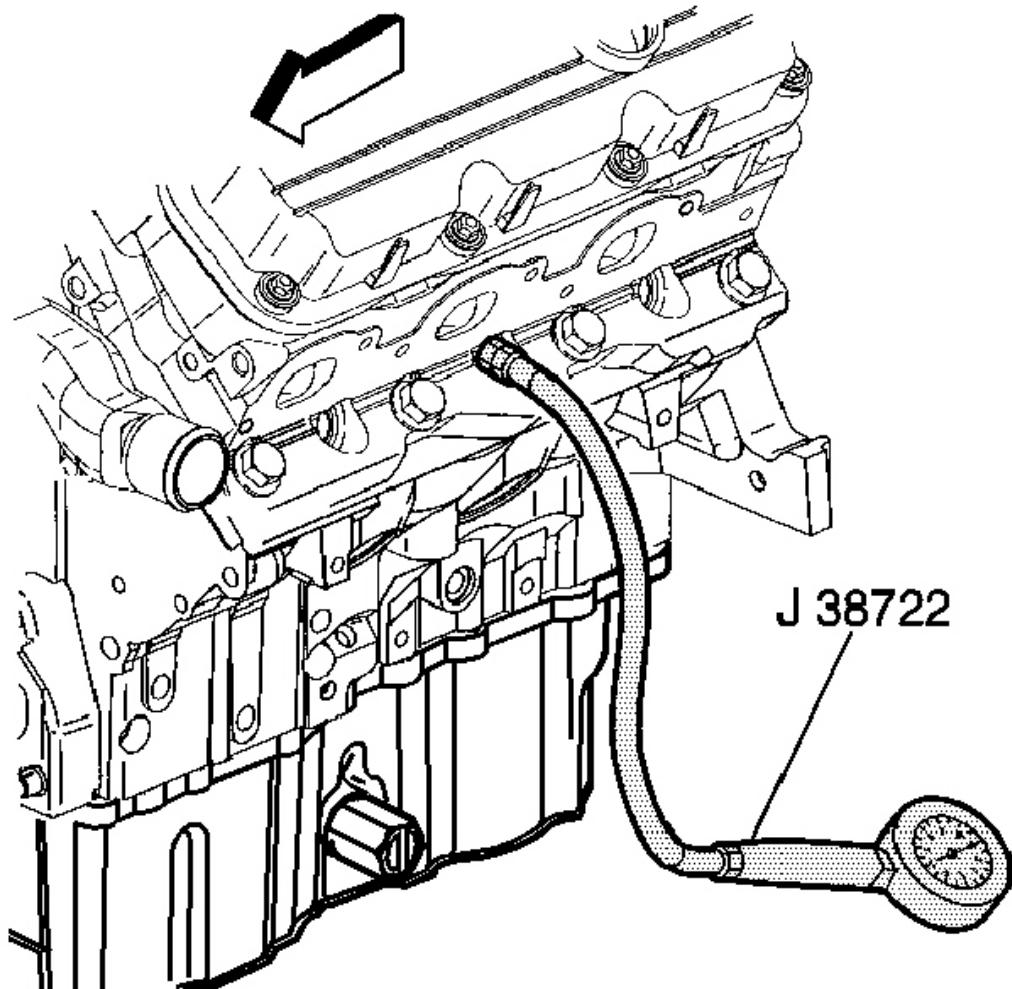
### Test Procedure

1. Run the engine until it reaches normal operating temperature. The battery must be at or near full charge.

2. Turn the engine OFF.

**IMPORTANT: Remove the Powertrain Control Module (PCM) and the ignition fuses from the I/P fuse block. Refer to Electrical Center Identification Views .**

3. Disable the ignition.
4. Disable the fuel systems.
5. Remove the spark plugs from all the cylinders.
6. Remove the air duct from the throttle body.
7. Block the throttle plate in the open position.



**Fig. 8: Measuring Engine Compression**  
Courtesy of GENERAL MOTORS CORP.

8. Measure the engine compression, using the following procedure:
  1. Firmly install **J 38722** to the spark plug hole. See **Special Tools**.
  2. Have an assistant crank the engine through at least four compression strokes in the testing cylinder.
  3. Check and record the readings on **J 38722** at each stroke. See **Special Tools**.
  4. Disconnect **J 38722**. See **Special Tools**.

5. Repeat the compression test for each cylinder.
9. Record the compression readings from all of the cylinders.
  - The lowest reading should not be less than 70 percent of the highest reading.
  - No cylinder reading should be less than 689 kPa (100 psi).
10. The following are examples of the possible measurements:
  - When the compression measurement is normal, the compression builds up quickly and evenly to the specified compression on each cylinder.
  - When the compression is low on the first stroke and tends to build up on the following strokes, but does not reach the normal compression or if the compression improves considerably with the addition of three squirts of oil, the piston rings may be the cause.
  - When the compression is low on the first stroke and does not build up in the following strokes or the addition of oil does not affect the compression, the valves may be the cause.
  - When the compression is low on two adjacent cylinders or coolant is present in the crankcase, the head gasket may be the cause.
11. Remove the block from the throttle plate.
12. Install the air duct to the throttle body.
13. Install the spark plugs.
14. Install the Powertrain Control Module (PCM) fuse.
15. Install the ignition fuse to the I/P fuse block.

## **CYLINDER LEAKAGE TEST**

### **Tools Required**

**J 35667-A** Cylinder Head Leakdown Tester. See **Special Tools**.

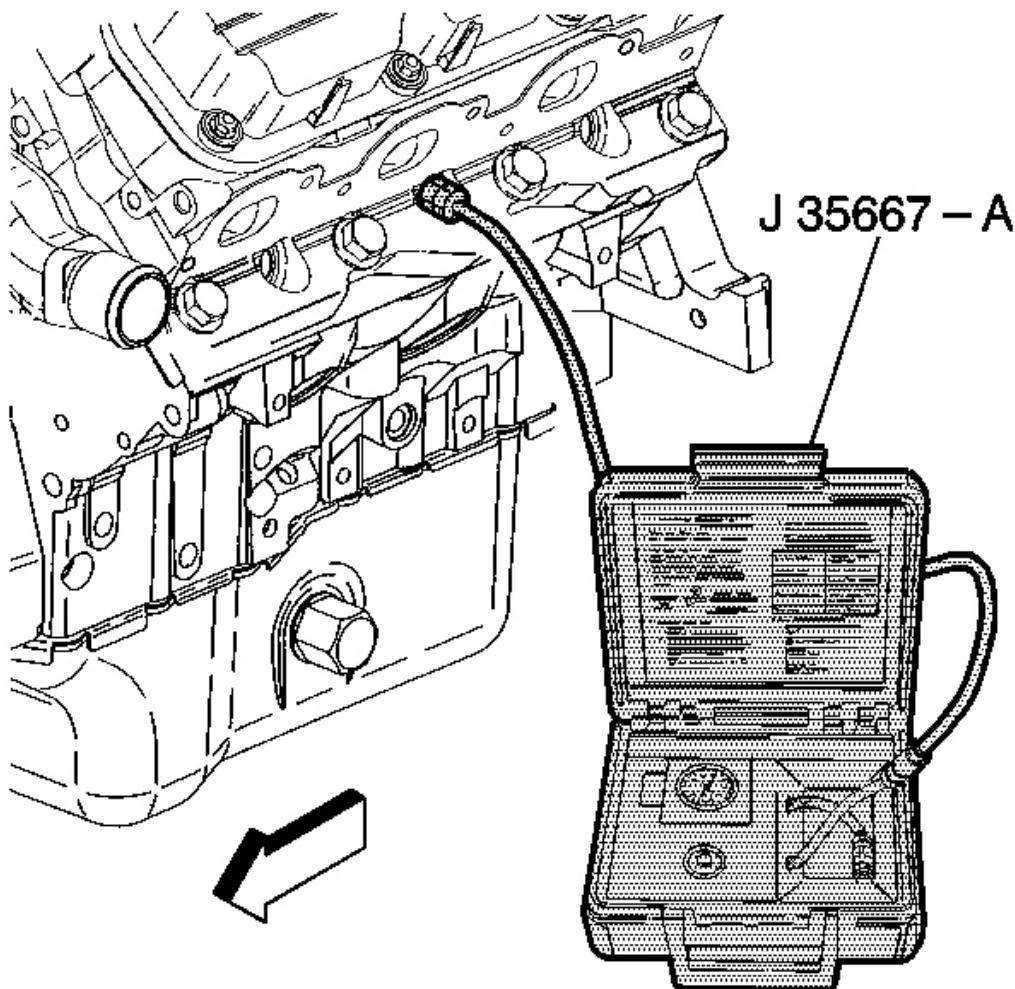
With the use of air pressure, a cylinder leakage test will aid in the diagnosis. The cylinder leakage test may be used in conjunction with the engine compression test, to isolate the cause of leaking cylinders.

### **Test Procedure**

**CAUTION: Refer to BATTERY DISCONNECT CAUTION .**

1. Remove the battery ground - negative cable.

2. Remove the spark plugs. Refer to Spark Plug Replacement .
3. Install the **J 35667-A** . See Special Tools.



**Fig. 9: Measuring Cylinder Leakage**

Courtesy of GENERAL MOTORS CORP.

4. Measure each cylinder on the compression stroke, with both valves closed.

**IMPORTANT:** It may be necessary to hold the crankshaft balancer bolt, to prevent piston movement.

5. Apply air pressure, using the **J 35667-A** . See **Special Tools**. Refer to the manufacturer's instructions.
6. Record the cylinder leakage readings for each cylinder.

**IMPORTANT:**

- **Normal cylinder leakage is from 12-18 percent.**
- **Make a note of any cylinder with more leakage than the other cylinders.**
- **Any cylinder with 30 percent leakage or more requires service.**

7. Inspect the four primary areas, to properly diagnose a leaking cylinder.
8. If air is heard from the intake or exhaust system, perform the following procedure:
  - Remove the valve rocker arm cover of the suspect cylinder head.
    - Ensure that both valves are closed.
    - Inspect the cylinder head for a broken valve spring.
  - Remove the suspect cylinder head and inspect. Refer to **Cylinder Head Cleaning and Inspection** .
9. If air is heard from the crankcase system at the crankcase, oil filler tube, perform the following procedure:
  - Remove the piston from the suspect cylinder.
  - Inspect the piston and connecting rod assembly. Refer to **Piston, Connecting Rod and Bearing Cleaning and Inspection** .
  - Inspect the engine block. Refer to **Engine Block Cleaning and Inspection** .
10. If bubbles are found in the radiator, perform the following procedure:
  - Remove both cylinder heads and inspect. Refer to **Cylinder Head Cleaning and Inspection** .
  - Inspect the engine block. Refer to **Engine Block Cleaning and Inspection** .
11. Remove the **J 35667-A** . See **Special Tools**.
12. Install the spark plugs. Refer to **Spark Plug Replacement** .
13. Install the battery ground - negative cable.

**OIL CONSUMPTION DIAGNOSIS**

An engine that has excessive oil consumption uses 0.9 L (1 qt) of oil or more, within 3 200 km (2,000 mi). The following list indicates the conditions and corrections of excessive oil

consumption:

- An improperly read oil level indicator - dipstick
  - Inspect the oil level while the vehicle is parked on a level surface.
  - Allow adequate drain-down time.
- Improper oil viscosity
  - Use the recommended SAE viscosity for prevailing temperatures.
  - Refer to **Maintenance Schedule (North American Emissions)** for the proper oil viscosity specifications.
- Continuous high-speed driving
- Severe hauling, such as a trailer-may causes decreased oil mileage.
- A malfunctioning crankcase ventilation system
- External oil leaks
  - Tighten the bolts, as needed.
  - Replace the gaskets and seals, as needed.
- Worn or omitted valve guides and/or valve stem seals
  - Ream the guides.
  - Install oversized service valves and/or new valve stem seals.
- Broken or worn piston rings
- Improperly installed or unseated piston rings
- Improperly installed or improperly fitted piston
- Plugged cylinder head gasket oil drain holes
- Damaged intake gaskets

## **OIL PRESSURE DIAGNOSIS AND TESTING**

### **Tools Required**

#### **J 25087-C Oil Pressure Tester**

If the vehicle has low oil pressure perform the following tests.

### **Low or No Oil Pressure**

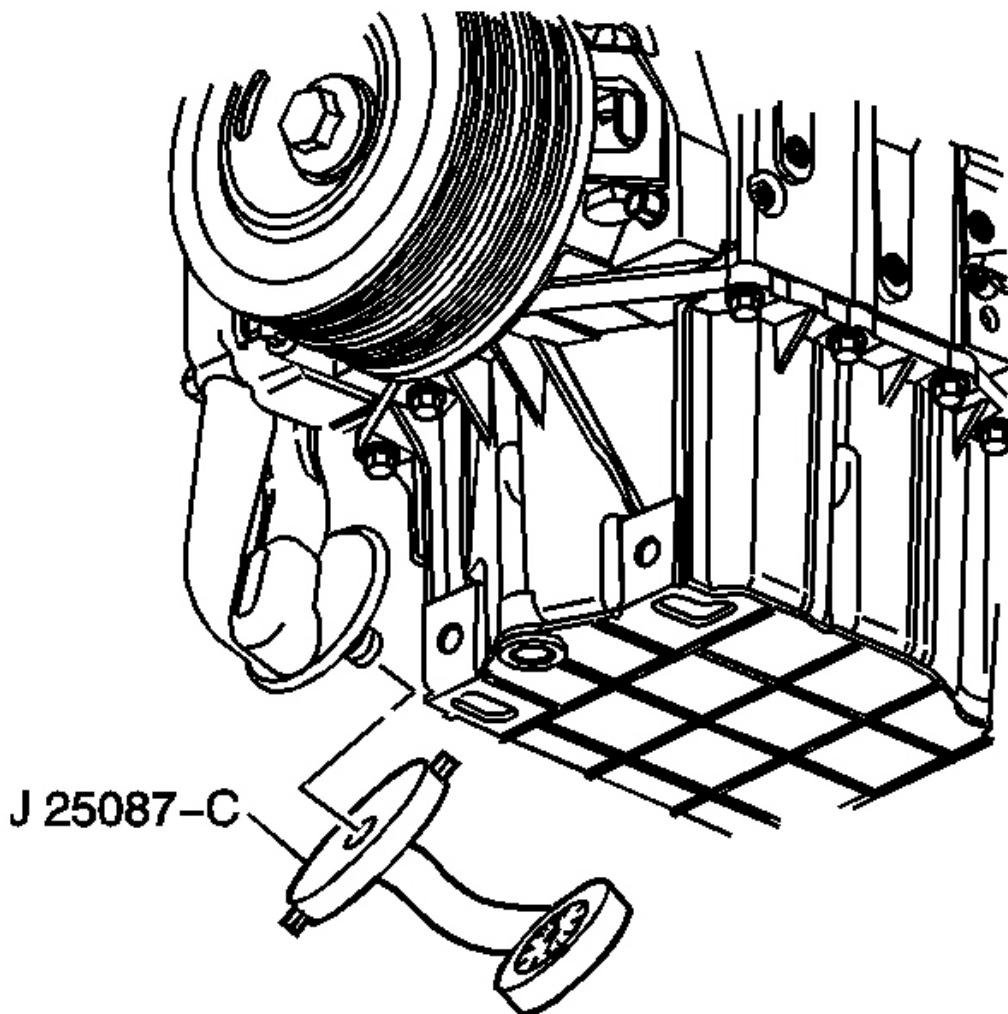
The following can cause low or no oil pressure:

- Low oil level - fill to the full mark on the oil level indicator.

- Slow idle speed
- Incorrect or malfunctioning oil pressure switch - replace the oil pressure switch.
- Incorrect or malfunctioning oil pressure gage - replace the oil pressure gage.
- Improper oil viscosity or diluted oil
  - Install oil of proper viscosity for expected temperature.
  - Install new oil if it is diluted.
- The oil pump is worn or dirty - clean or replace the oil pump.
- The oil filter is plugged - replace the oil filter.
- The oil pickup screen is loose or plugged - replace the oil pickup screen.
- A hole in the oil pickup tube - replace the oil pickup tube.
- Excessive bearing clearance - replace the bearings.
- Cracked, porous or plugged oil galleries - repair or replace the engine block.
- The gallery plugs are missing or improperly installed - install or repair as necessary.
- The pressure regulator valve is stuck.
  - Check the pressure regulator valve for sticking in the bore.
  - Check the bore for scoring and burrs.
- The camshaft is worn or poorly machined - replace the camshaft.
- Worn valve guides - repair as needed.

#### Oil Pressure Testing

1. Check the oil level.
2. Raise the vehicle and remove the oil filter.
3. Assemble the plunger valve in the large hole of **J 25087-C** base and the hose in the small hole of **J 25087-C** base. Connect the gage to the end of the hose.
4. Insert the flat side of the rubber plug in the bypass valve without depressing the bypass valve itself.
5. Install **J 25087-C** on the filter mounting pad.



**Fig. 10: Measuring Oil Pressure**  
Courtesy of GENERAL MOTORS CORP.

6. Start the engine and check the overall oil pressure, the oil pressure switch and for noisy lifters. The engine should be at operating temperature before checking the oil pressure. The oil pressure should be approximately 414 kPa (60 psi) at 1850 RPM using 10W30 engine oil.
7. If adequate oil pressure is indicated, check the oil pressure switch.
8. If a low reading is indicated, press the valve on the tester base to isolate the oil pump and/or its components from the lubricating system. An adequate reading at this time indicates a

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good pump and the previous low pressure was due to worn bearings, etc. A low reading while pressing the valve would indicate a faulty pump.

### OIL LEAK DIAGNOSIS

#### Oil Leak Diagnosis

Step	Action	Yes	No
<b>IMPORTANT:</b> You can repair most fluid leaks by first visually locating the leak, repairing or replacing the component or by resealing the gasket surface. Once the leak is identified, determine the cause of the leak. Repair the cause of the leak as well as the leak itself.			
1	<ol style="list-style-type: none"><li>1. Operate the vehicle until it reaches normal operating temperature.</li><li>2. Park the vehicle on a level surface, over a large sheet of paper or other clean surface.</li><li>3. Wait 15 minutes.</li><li>4. Inspect for drippings.</li></ol> <p>Are drippings present?</p>	Go to Step 2	System OK
2	Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 3
3	<ol style="list-style-type: none"><li>1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas.</li><li>2. Inspect for leaks at the following locations:<ul style="list-style-type: none"><li>• Sealing surfaces</li><li>• Fittings</li><li>• Cracked or damaged components</li></ul></li></ol> <p>Can you identify the type of fluid and the approximate location of the leak?</p>	Go to Step 10	Go to Step 4
	<ol style="list-style-type: none"><li>1. Completely clean the entire engine and surrounding components.</li><li>2. Operate the vehicle for several</li></ol>		

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4	<p>kilometers, miles, at normal operating temperature and at varying speeds.</p> <ol style="list-style-type: none"><li>3. Park the vehicle on a level surface, over a large sheet of paper or other clean surface.</li><li>4. Wait 15 minutes.</li><li>5. Identify the type of fluid and the approximate location of the leak.</li></ol> <p>Can you identify the type of fluid and the approximate location of the leak?</p>		Go to <b>Step 10</b>	Go to <b>Step 5</b>
5	<ol style="list-style-type: none"><li>1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas.</li><li>2. Inspect for leaks at the following locations:<ul style="list-style-type: none"><li>• Sealing surfaces</li><li>• Fittings</li><li>• Cracked or damaged components</li></ul></li></ol> <p>Can you identify the type of fluid and the approximate location of the leak?</p>		Go to <b>Step 10</b>	Go to <b>Step 6</b>
6	<ol style="list-style-type: none"><li>1. Completely clean the entire engine and surrounding components.</li><li>2. Apply an aerosol-type powder, baby powder, foot powder, etc., to the suspected area.</li><li>3. Operate the vehicle for several kilometers, miles, at normal operating temperature and at varying speeds.</li><li>4. Identify the type of fluid and the approximate location of the leak, from the discolorations in the powder surface.</li></ol>			

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	<p>Can you identify the type of fluid and the approximate location of the leak?</p>	<b>Go to Step 10</b>	<b>Go to Step 7</b>
7	<ol style="list-style-type: none"> <li>1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas.</li> <li>2. Inspect for leaks at the following locations:           <ul style="list-style-type: none"> <li>• Sealing surfaces</li> <li>• Fittings</li> <li>• Cracked or damaged components</li> </ul> </li> </ol> <p>Can you identify the type of fluid and the approximate location of the leak?</p>	<b>Go to Step 10</b>	<b>Go to Step 8</b>
8	<p>Use the <b>J 28428-E</b> high intensity black light kit in order to identify the type of fluid and the approximate location of the leak. See <b>Special Tools</b>. Refer to the manufacturer's instructions when using the tool.</p> <p>Can you identify the type of fluid and the approximate location of the leak?</p>	<b>Go to Step 10</b>	<b>Go to Step 9</b>
9	<ol style="list-style-type: none"> <li>1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas.</li> <li>2. Inspect for leaks at the following locations:           <ul style="list-style-type: none"> <li>• Sealing surfaces</li> <li>• Fittings</li> <li>• Cracked or damaged components</li> </ul> </li> </ol> <p>Can you identify the type of fluid and the approximate location of the leak?</p>	<b>Go to Step 10</b>	System OK
	<ol style="list-style-type: none"> <li>1. Inspect the engine for mechanical damage. Special attention should be</li> </ol>		

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10	<p>shown to the following areas:</p> <ul style="list-style-type: none"><li>• Higher than recommended fluid levels</li><li>• Higher than recommended fluid pressures</li><li>• Plugged or malfunctioning fluid filters or pressure bypass valves</li><li>• Plugged or malfunctioning engine ventilation system</li><li>• Improperly tightened or damaged fasteners</li><li>• Cracked or porous components</li><li>• Improper sealants or gaskets, where required</li><li>• Improper sealant or gasket installation</li><li>• Damaged or worn gaskets or seals</li><li>• Damaged or worn sealing surfaces</li></ul> <p>2. Inspect the engine for customer modifications.</p> <p>Is there mechanical damage or customer modifications to the engine?</p>		
11	<p>Repair or replace all damaged or modified components.</p> <p>Does the engine still leak oil?</p>	<p>Go to <b>Step 11</b></p>	<p>System OK</p>

## CRANKCASE VENTILATION SYSTEM INSPECTION/DIAGNOSIS

### Crankcase Ventilation System Inspection/Diagnosis

Concern	Action
External oil leak	<p>Inspect for any of the following conditions:</p> <ul style="list-style-type: none"><li>• Restricted or kinked positive crankcase ventilation (PCV) tube or engine vent hose</li></ul>

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	<ul style="list-style-type: none"><li>• Damaged, incorrect or incorrectly installed PCV tube</li><li>• Excessive crankcase pressure</li></ul>
Rough Idle	Inspect for any of the following conditions: <ul style="list-style-type: none"><li>• Restricted or kinked PCV tube or engine vent hose</li><li>• Leaking (damaged) PCV tube</li></ul>
Stalling or slow idle speed	Inspect for any of the following conditions: <ul style="list-style-type: none"><li>• Restricted or kinked engine vent hose</li><li>• Leaking (damaged) PCV tube</li></ul>
High idle speed	Inspect for a leaking (damaged) PCV tube
Sludge in the engine	Inspect for a restricted or kinked PCV tube or engine vent hose

## DRIVE BELT CHIRPING DIAGNOSIS

### Diagnostic Aids

The chirping noise may be intermittent due to moisture on the drive belt or the accessory drive pulley(s). In order to duplicate the customer's concern, it may be necessary to spray a small amount of water onto the drive belt. If spraying water onto the drive belt duplicates the symptom, cleaning the accessory drive belt pulley(s) may be the most probable solution.

A loose or improper installation of a body component, a suspension component or other item(s) on the vehicle may also cause the chirping noise.

### Test Description

The number(s) below refer to the step(s) in the diagnostic table.

**2:** The chirping noise may not be engine related. This step is to verify that the engine is making the noise. If the engine is not making the noise do not proceed any further in this table.

**3:** The noise may be an internal engine noise. Remove the drive belt and operate the engine for a few seconds, this will verify if the chirping noise is related to the drive belt or not. With the drive belt removed the water pump will not operate and the engine may overheat. Also diagnostic trouble codes (DTCs) may set when the engine is operated with the drive belt removed.

**4:** Inspect the drive belt for signs of pilling. Pilling is the small balls, pills or strings in the

drive belt grooves caused by the accumulation of rubber dust.

**6:** Misalignment of the accessory drive pulley(s) may be caused from improper mounting or incorrect installation of an the accessory drive component or the pulley may be bent inward or outward from a previous repair. Test for a misaligned accessory drive pulley using a straight edge in the pulley grooves across two or three pulleys. If a misaligned pulley is found, refer to that accessory drive component for the proper removal and installation procedure for that pulley.

**10:** Inspection of the fasteners can eliminate the possibility that a incorrect bolt, nut, spacer or washer was installed.

**12:** Inspection of the accessory drive pulley(s) should include inspecting for bends, dents or other damage to the pulley(s) that would prevent the drive belt from seating properly in the pulley grooves or on the smooth surface of the pulley when the back side of the drive belt is used to drive the pulley.

**14:** Replacing the drive belt when it is not damaged or there is not excessive pilling will only be a temporary repair.

## Drive Belt Chirping Diagnosis

Step	Action	Yes	No
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### NOTE:

Refer to **BELT DRESSING NOTICE**.

**DEFINITION:** The following items are indications of chirping:

- A high pitched noise that is heard once per revolution of the drive belt or accessory drive pulley
- Chirping may occur on cold damp startup conditions and will subside once the vehicle reaches normal operating temperature.

1	Did you review the Symptoms - Engine Mechanical diagnostic information and perform the necessary inspections?	Go to Step 2	Go to <b><u>Symptoms - Engine Mechanical</u></b>
2	Verify that there is a chirping noise. Does the engine make the chirping noise?	Go to Step 3	Go to Diagnostic Aids
3	1. Remove the drive belt. Refer to <b><u>Drive Belt Replacement</u></b> . 2. Operate the engine for no longer than 30 to 40 seconds.	Go to <b><u>Symptoms - Engine</u></b>	

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	Does the chirping noise still exist?	<u>Mechanical</u>	Go to Step 4
<b>4</b>	Inspect for severe drive belt pilling exceeding 1/3 of the drive belt groove depth. Do the drive belt grooves have pilling?	Go to Step 5	Go to Step 6
<b>5</b>	Clean the drive belt pulley(s) with a suitable wire brush. Were the accessory drive pulley(s) cleaned?	Go to Step 15	Go to Step 6
<b>6</b>	Inspect for a misaligned accessory drive pulley(s). Is there a misaligned accessory drive pulley?	Go to Step 7	Go to Step 8
<b>7</b>	Replace and/or repair the misaligned accessory drive pulley(s). Were the misaligned accessory drive pulley(s) replaced and/or repaired?	Go to Step 15	Go to Step 8
<b>8</b>	Inspect for a bent or cracked accessory drive bracket(s). Did you find any bent or cracked accessory drive bracket(s)?	Go to Step 9	Go to Step 10
<b>9</b>	Replace the bent and/or cracked accessory drive bracket(s). Was the bent and/or cracked accessory drive bracket(s) replaced?	Go to Step 15	Go to Step 10
<b>10</b>	Inspect for incorrect, loose and/or missing fasteners. Were there any incorrect, loose, and/or missing fasteners found?	Go to Step 11	Go to Step 12
<b>11</b>	<p>1. Replace any incorrect and/or missing fasteners.</p> <p><b>NOTE:</b> Refer to <u>Fastener Notice</u> .</p> <p>2. Tighten any loose fasteners. Refer to <u>Fastener Tightening Specifications</u>.</p> <p>Were the fasteners replaced and/or tightened?</p>	Go to Step 15	Go to Step 12

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12	Inspect for a bent accessory drive pulley(s). Was a bent accessory drive pulley(s) found?	Go to Step 13	Go to Step 14
13	Replace the bent accessory drive pulley(s). Was the drive belt(s) replaced?	Go to Step 15	Go to Step 14
14	Replace the drive belt. Refer to <b><u>Drive Belt Replacement</u></b> . Was the drive belt(s) replaced?	Go to Step 15	Go to Diagnostic Aids
15	<ol style="list-style-type: none"> <li>1. Clear any codes.</li> <li>2. Run the engine in order to verify the repair.</li> </ol> <p>Does the chirping noise still exist?</p>	-	System OK

### DRIVE BELT SQUEAL DIAGNOSIS

#### Diagnostic Aids

The drive belt will not cause the whine.

If the whine is intermittent, verify that it is not the accessory drive component(s) by varying their loads, making sure they are operating to their maximum capacity. An overcharged air conditioning (A/C) system, a power steering system restriction or the incorrect fluid or a failing generator are suggested items to inspect.

#### Test Description

The number(s) below refer to the step(s) in the diagnostic table.

**3:** This test is to verify that the whine is being caused by the accessory drive component(s). Remove the drive belt and operate the engine for a few seconds, this will verify if the whining noise is related to the accessory drive component. With the drive removed the water pump will not operate and the engine may overheat. Also diagnostic trouble codes (DTCs) may set when the engine is operated with the drive belt removed.

**4:** This inspection should include checking the drive belt tensioner and the drive belt idler pulley bearings. The drive belt may have to be installed and the accessory drive components operated separately by varying their loads. Refer to the suspected accessory drive component for the proper removal and installation procedure.

### Drive Belt Squeal Diagnosis

Step	Action	Yes	No
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### NOTE:

Refer to **BELT DRESSING NOTICE**.

**DEFINITION:** A high pitched continuous noise that may be caused by an accessory drive component failed bearing

1	Did you review the Symptoms - Engine Mechanical diagnostic information and perform the necessary inspections?	Go to Step 2	Go to <b><u>Symptoms - Engine Mechanical</u></b>
2	Verify that there is a whining noise. Does the engine make the whining noise?	Go to Step 3	Go to Diagnostic Aids
3	1. Remove the drive belt. Refer to <b><u>Drive Belt Replacement</u></b> . 2. Operate the engine for no longer than 30 to 40 seconds.  Does the whining noise still exist?	Go to <b><u>Symptoms - Engine Mechanical</u></b>	Go to Step 4
4	1. Inspect for a failed accessory drive component bearing. 2. Install the drive belt. Refer to <b><u>Drive Belt Replacement</u></b> .  Did you find and correct the condition?	Go to Step 5	Go to Diagnostic Aids
5	1. Clear any codes. 2. Run the engine in order to verify the repair.  Did you correct the condition?	-	System OK

### DRIVE BELT WHINE DIAGNOSIS

#### Diagnostic Aids

The drive belt will not cause the whine.

If the whine is intermittent, verify that it is not the accessory drive component(s) by varying their loads, making sure they are operating to their maximum capacity. An overcharged air conditioning (A/C) system, a power steering system restriction or the incorrect fluid or a failing generator are suggested items to inspect.

**Test Description**

The number(s) below refer to the step(s) in the diagnostic table.

**3:** This test is to verify that the whine is being caused by the accessory drive component(s). Remove the drive belt and operate the engine for a few seconds, this will verify if the whining noise is related to the accessory drive component. With the drive removed the water pump will not operate and the engine may overheat. Also diagnostic trouble codes (DTCs) may set when the engine is operated with the drive belt removed.

**4:** This inspection should include checking the drive belt tensioner and the drive belt idler pulley bearings. The drive belt may have to be installed and the accessory drive components operated separately by varying their loads. Refer to the suspected accessory drive component for the proper removal and installation procedure.

**Drive Belt Whine Diagnosis**

Step	Action	Yes	No
<b>NOTE:</b>			
Refer to <b><u>BELT DRESSING NOTICE</u></b> .			
1	Did you review the Symptoms - Engine Mechanical diagnostic information and perform the necessary inspections?	Go to Step 2	Go to <b><u>Symptoms - Engine Mechanical</u></b>
2	Verify that there is a whining noise. Does the engine make the whining noise?	Go to Step 3	Go to Diagnostic Aids
3	1. Remove the drive belt. Refer to <b><u>Drive Belt Replacement</u></b> . 2. Operate the engine for no longer than 30 to 40 seconds.  Does the whining noise still exist?	Go to <b><u>Symptoms - Engine Mechanical</u></b>	Go to Step 4
4	1. Inspect for a failed accessory drive component bearing. 2. Install the drive belt. Refer to <b><u>Drive Belt Replacement</u></b> .  Did you find and correct the condition?	Go to Step 5	Go to Diagnostic Aids

5	<ol style="list-style-type: none"><li>1. Clear any codes.</li><li>2. Run the engine in order to verify the repair.</li></ol>	-	System OK
Did you correct the condition?			

## DRIVE BELT RUMBLING DIAGNOSIS

### Diagnostic Aids

Vibration from the engine operating may cause a body component or another part of the vehicle to make the rumbling noise.

The drive belt may have a condition that can not be seen or felt. Sometimes replacing the drive belt may be the only repair for the symptom.

If replacing the drive belt and completing the diagnostic table and the rumbling is only heard with the drive belt installed, there might be an accessory drive component with a failure. Varying the load on the accessory drive component(s) may aid in identifying which component is causing the rumbling noise.

### Test Description

The number(s) below refer to the step(s) in the diagnostic table.

**2:** This test is to verify that the symptom is present during diagnosing. Other vehicle components may cause a similar symptom.

**3:** This test is to verify that the drive belt is causing the rumbling. Rumbling may be confused with an internal engine noise due to the similarity in the description. Remove only one drive belt at a time if the vehicle has multiple drive belts. Operate the engine for a few seconds, this will verify if the rumbling noise is related to the drive belt or not. With the drive belt removed the water pump will not be operate and the engine may overheat. Also diagnostic trouble codes (DTCs) may set when the engine is operated with the drive belt removed.

**4:** Inspect the drive belt to ensure that the drive belt is not the cause of the noise. Small cracks across the ribs of the drive belt will not cause the noise. Belt separation is identified by the plys of the belt separating and may be seen at the edge of the belt our felt as a lump in the belt.

**5:** Small amounts of pilling is normal condition and acceptable. When the pilling is severe the drive belt does not have a smooth surface for proper operation.

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### Drive Belt Rumbling Diagnosis

Step	Action	Yes	No
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**NOTE:**

Refer to **BELT DRESSING NOTICE**.

**DEFINITION:**

- A low pitch tapping, knocking or thumping noise heard at or just above idle.
- Heard once per revolution of the drive belt or pulley.
- Rumbling may be caused from:
  - Pilling, the accumulation of rubber dust that forms small balls (pills) or strings in the drive belt pulley groove
  - The separation of the drive belt
  - A damaged drive belt

1	Did you review the Symptoms-Engine Mechanical diagnostic information and perform the necessary inspections?	Go to Step 2	<u>Go to Symptoms - Engine Mechanical</u>
2	Verify that there is a rumbling noise. Does the engine make the rumbling noise?	Go to Step 3	Go to Diagnostic Aids
3	1. Remove the drive belt. Refer to <b><u>Drive Belt Replacement</u></b> . 2. Operate the engine for no longer than 30 to 40 seconds.  Does the rumbling noise still exist?	<u>Go to Symptoms - Engine Mechanical</u>	Go to Step 4
4	Inspect the drive belt for damage, separation or sections of missing ribs. Were any of these conditions found?	Go to Step 7	Go to Step 5
5	Inspect for severe pilling of more than 1/3 of the drive belt pulley grooves. Do the drive belt grooves have pilling?	Go to Step 6	Go to Step 7
6	1. Clean the drive belt pulleys using a suitable wire brush. 2. Reinstall the drive belt. Refer to <b><u>Drive Belt Replacement</u></b> .		

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	Did you complete the repair?	Go to Step 8	Go to Step 7
7	Install a new drive belt. Refer to <u>Drive Belt Replacement</u> . Did you complete the replacement?		
8	1. Clear any codes. 2. Run the engine in order to verify the repair.  Does the rumbling noise still exist?		System OK

### DRIVE BELT VIBRATION DIAGNOSIS

#### Diagnostic Aids

The accessory drive components may have an affect on engine vibration. An overcharged air conditioning (A/C) system, a power steering system restriction or the incorrect fluid or an extra load placed on the generator are suggested items to inspect. To help identify an intermittent or an improper condition, vary the loads on the accessory drive components.

#### Test Description

The number(s) below refer to the step(s) in the diagnostic table.

**2:** This test is to verify that the vibration is present during diagnosing. Other vehicle components may cause a similar symptom such as the exhaust system or the drivetrain.

**3:** This test is to verify that the drive belt or accessory drive components may be causing the vibration. Remove the drive belt and operate the engine for a few seconds, this will verify if the vibration is related to the drive belt or not. With the drive belt removed the water pump will not operate and the engine may overheat. Also diagnostic trouble codes (DTCs) may set when the engine is operated with the drive belt removed.

**4:** The drive belt may cause a vibration. While the drive belt is removed this is the best time to inspect the condition of the belt.

**6:** Inspection of the fasteners can eliminate the possibility that a incorrect bolt, nut, spacer or washer was installed.

**8:** This step should only be performed if the fan is driven by the drive belt. Inspect the engine cooling fan for being bent, twisted, loose or having cracked blades. Inspect the fan clutch for smooth operation. Inspect for a bent fan shaft or bent mounting flange.

**9:** Accessory drive component brackets that are bent, cracked or loose may put extra strain on that accessory component causing it to vibrate.

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### Drive Belt Vibration Diagnosis

Step	Action	Yes	No
------	--------	-----	----

**NOTE:**

Refer to **BELT DRESSING NOTICE**.

**DEFINITION:** The following items are indications of drive belt vibration:

- The vibration is engine-speed related.
- The vibration may be sensitive to accessory load.

1	Did you review the Symptoms - Engine Mechanical diagnostic information and perform the necessary inspections?	Go to Step 2	Go to <b><u>Symptoms - Engine Mechanical</u></b>
2	Verify that the vibration is engine related. Does the engine make the vibration?	Go to Step 3	Go to Diagnostic Aids
3	<ol style="list-style-type: none"> <li>1. Remove the drive belt. Refer to <b><u>Drive Belt Replacement</u></b>.</li> <li>2. Operate the engine for no longer than 30 to 40 seconds.</li> </ol> <p>Does the engine still make the vibration?</p>	Go to <b><u>Vibration Analysis - Engine</u></b>	Go to Step 4
4	Inspect the drive belt for wear, damage, debris build-up and missing drive belt ribs. Were any of these conditions found?	Go to Step 5	Go to Step 6
5	<p>Install a new drive belt. Refer to <b><u>Drive Belt Replacement</u></b>.</p> <p>Did you complete the replacement?</p>	Go to Step 10	-
6	Inspect for incorrect, loose and/or missing fasteners. Were any of these conditions found?	Go to Step 7	Go to Step 8
7	<ol style="list-style-type: none"> <li>1. Replace incorrect or missing fasteners.</li> </ol> <p><b>NOTE:</b> Refer to <b><u>FASTENER NOTICE</u></b>.</p> <ol style="list-style-type: none"> <li>2. Tighten any loose fasteners. Refer to <b><u>Fastener Tightening</u></b></li> </ol>		

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<u>Specifications.</u>			
	Were the fasteners replaced and/or tightened?	Go to Step 10	-
8	Inspect for damaged fan blades or a bent fan clutch shaft. Did you find and correct the condition?	Go to Step 10	Go to Step 9
9	Inspect for a bent or cracked accessory drive bracket(s). Did you find and correct the condition?	Go to Step 10	Go to Diagnostic Aids
10	1. Clear any codes. 2. Run the engine in order to verify the repair.  Does the vibration still exist?	-	System OK

## DRIVE BELT FALLS OFF DIAGNOSIS

### Diagnostic Aids

If the drive belt repeatedly falls off of the accessory drive pulley(s), this may be caused by a pulley misalignment.

An extra load that is quickly applied or released by an accessory drive component may cause the drive belt to fall off. Verify that the accessory drive components are operating properly.

If the drive belt is the incorrect length, the drive belt tensioner may not maintain the proper tension on the drive belt.

### Test Description

The number(s) below refer to the step(s) on the diagnostic table.

**2:** This inspection is to verify the condition of the drive belt. Damage may have occurred to the drive belt when the drive belt fell off the pulley. Inspect the drive belt for cuts, tears, sections of ribs missing or damaged belt plies.

**4:** Misalignment of the accessory drive pulley(s) may be caused from improper mounting or incorrect installation of a accessory drive component or the pulley may be bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across two or three pulleys. If a misaligned pulley is found refer to that

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accessory drive component for the proper removal and installation procedure of that pulley.

**5:** Inspection of the accessory drive pulley(s) should include inspecting for bends, dents or other damage that would prevent the drive belt from seating properly in the pulley grooves or on the smooth surface of a pulley when the back side of the drive belt is used to drive the pulley.

**6:** Accessory drive component brackets that are bent or cracked will also cause the drive belt fall off.

**7:** Inspection of the fasteners can eliminate the possibility that an incorrect bolt, nut, spacer or washer was installed. Missing, loose or incorrect fasteners may cause pulley misalignment from the accessory drive bracket(s) moving under load. Over tightening the fasteners may cause misalignment of the accessory component bracket(s).

### Drive Belt Falls Off Diagnosis

Step	Action	Yes	No
<b>NOTE:</b> Refer to <u><b>BELT DRESSING NOTICE</b></u> .			
<b>DEFINITION:</b> The drive belt falls off the pulleys or may not ride correctly on the pulleys.			
1	Did you review the Symptom - Engine Mechanical diagnostic information and perform the necessary inspections?	Go to Step 2	Go to <u><b>Symptoms - Engine Mechanical</b></u>
2	Inspect for a damaged drive belt. Was a damaged drive belt found?	Go to Step 3	Go to Step 4
3	Install a new drive belt. Refer to <u><b>Drive Belt Replacement</b></u> . Does the drive belt continue to fall off?	Go to Step 4	System OK
4	Inspect for misaligned accessory drive pulley(s). Did you find and correct the condition?	Go to Step 12	Go to Step 5
5	Inspect for a bent or dented accessory drive pulley(s). Did you find and correct the condition?	Go to Step 12	Go to Step 6
6	Inspect for a bent or a cracked accessory drive bracket(s). Did you find and correct the condition?	Go to Step 12	Go to Step 7
	Inspect for incorrect, loose and/or missing fasteners.		

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7	Were there any incorrect, loose and/or missing fasteners?	Go to Step 8	Go to Step 9
8	<p>1. Replace any incorrect and/or missing fasteners.</p> <p><b>NOTE:</b> Refer to <b><u>FASTENER NOTICE</u></b>.</p> <p>2. Tighten any loose fasteners. Refer to <b><u>Fastener Tightening Specifications</u></b>.</p> <p>Does the drive belt continue to fall off?</p>	Go to Step 9	System OK
9	<p>Test the drive belt tensioner for correct operation. Refer to <b><u>Drive Belt Tensioner Diagnosis</u></b>.</p> <p>Does the drive belt tensioner operate correctly?</p>	Go to Step 11	Go to Step 10
10	<p>Replace the drive belt tensioner. Refer to <b><u>Drive Belt Tensioner Replacement</u></b>.</p> <p>Does the drive belt continue to fall off?</p>	Go to Step 11	System OK
11	<p>Inspect for a failed drive belt idler and/or tensioner pulley bearings.</p> <p>Did you find and repair the condition?</p>	Go to Step 12	Go to Diagnostic Aids
12	<p>Run the engine to verify the repair.</p> <p>Does the drive belt still fall off?</p>	-	System OK

### DRIVE BELT EXCESSIVE WEAR DIAGNOSIS

#### Diagnostic Aids

Excessive wear on a drive belt is usually caused by incorrect installation or the incorrect drive belt for the application.

Minor misalignment of the accessory drive belt pulley(s) will not cause excessive wear, but will probably cause the drive belt to make a noise or fall off.

Excessive misalignment of the accessory drive belt pulley(s) will cause excessive wear but may also make the drive belt fall off.

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### Test Description

The number(s) below refer to the step(s) in the diagnostic table.

**2:** This inspection is to verify the drive belt is correctly installed on all of the accessory drive pulleys. Wear on the drive belt may be caused by mis-positioning the drive belt by one or more grooves on a pulley(s).

**3:** The installation of a drive belt that is too wide or too narrow will cause wear on the drive belt. The drive belt ribs should match all of the grooves on the pulleys.

**4:** This inspection is to verify the drive belt is not contacting any part of the engine or body while the engine is operating. There should be sufficient clearance when the accessory drive components load varies. This drive belt should not come in contact with an engine or a body component when snapping the throttle.

### Drive Belt Excessive Wear Diagnosis

Step	Action	Yes	No
<b>NOTE:</b> Refer to <u><a href="#">BELT DRESSING NOTICE</a></u> .			
DEFINITION: Wear at the outside ribs of the drive belt due to incorrect installation of the drive belt.			
1	Did you review the Symptoms - Engine Mechanical diagnostic information and perform the necessary inspections?	Go to Step 2	<u><a href="#">Symptoms - Engine Mechanical</a></u>
2	Inspect the drive belt for proper installation. Is the drive belt installed correctly?	Go to Step 5	Go to Step 3
3	Inspect for the correct drive belt. Is the correct drive belt installed?	Go to Step 5	Go to Step 4
4	Inspect the drive belt for signs of rubbing against a bracket, hose or wiring harness. Was the drive rubbing against anything?	Go to Step 6	Go to Diagnostic Aids
5	Replace the drive belt. Refer to <u><a href="#">Drive Belt Replacement</a></u> . Did you complete the replacement?	Go to Step 6	-
6	Run the engine in order to verify the repair Is there still excessive drive belt wear?	-	System OK

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### DRIVE BELT TENSIONER DIAGNOSIS

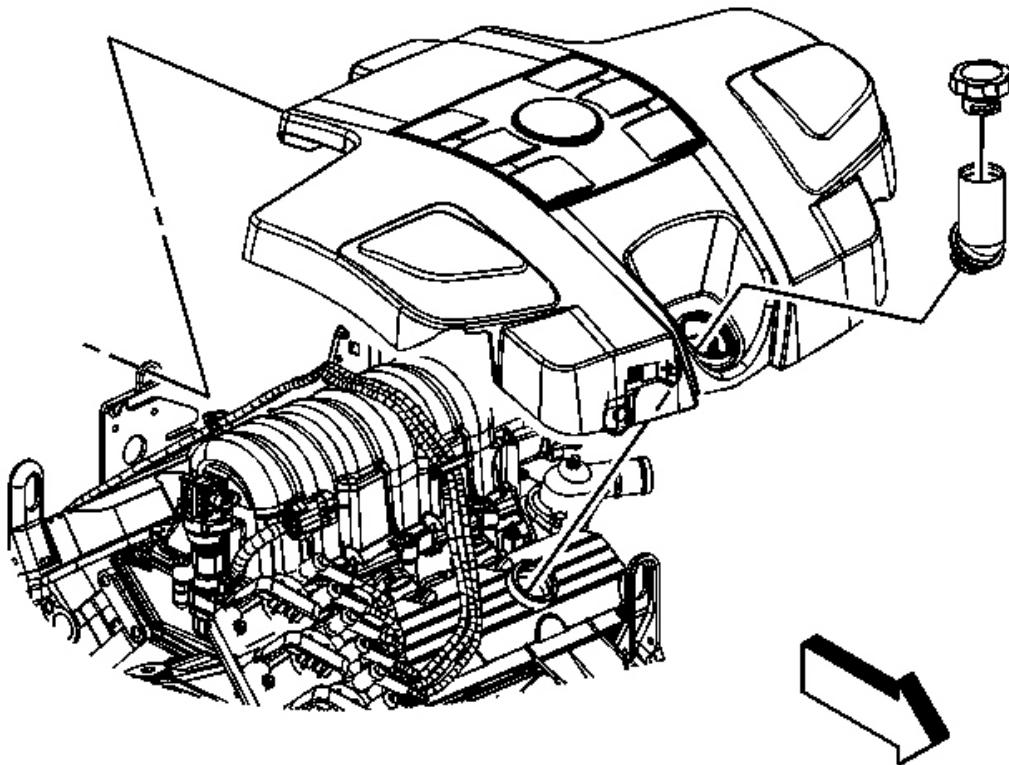
#### Drive Belt Tensioner Diagnosis

Step	Action	Yes	No
1	<ol style="list-style-type: none"><li>1. Remove the drive belt. Refer to <a href="#"><u>Drive Belt Replacement</u></a>.</li><li>2. Inspect the drive belt tensioner pulley.  Is the drive belt tensioner pulley loose or misaligned?</li></ol>		
2	<p>Rotate the drive belt tensioner. Does the tensioner rotate without any unusual resistance or binding?</p>	<a href="#">Go to Step 4</a>	<a href="#">Go to Step 2</a>
3	<ol style="list-style-type: none"><li>1. Use a torque wrench in order to measure the torque required to move the tensioner off of the stop.</li><li>2. Use a torque wrench on a known good tensioner in order to measure the torque required to move the tensioner off of the stop.</li></ol> Is the first torque reading within 10 percent of the second torque reading?		
4	<ol style="list-style-type: none"><li>1. Replace the drive belt tensioner. Refer to <a href="#"><u>Drive Belt Tensioner Replacement</u></a>.</li><li>2. Install the drive belt. Refer to <a href="#"><u>Drive Belt Replacement</u></a>.</li></ol> Is the repair complete?	<a href="#">System OK</a>	<a href="#">Go to Step 4</a>

### REPAIR INSTRUCTIONS - ON VEHICLE

#### INTAKE MANIFOLD COVER REPLACEMENT

##### Removal Procedure

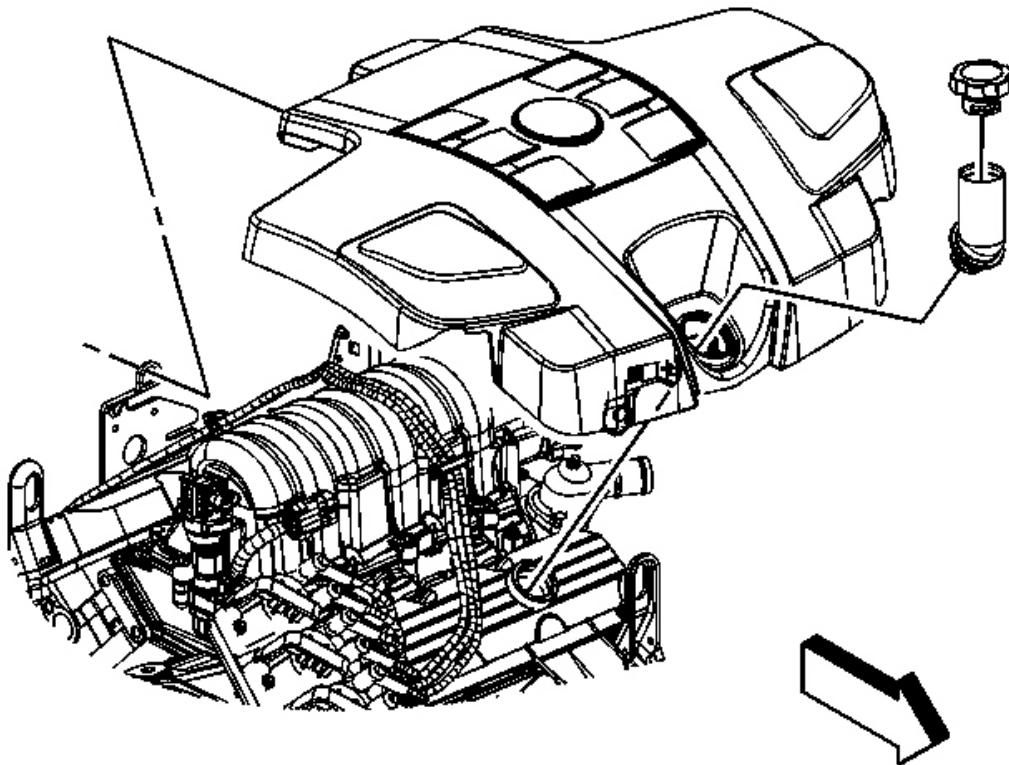


**Fig. 11: View Of Intake Manifold Cover**

Courtesy of GENERAL MOTORS CORP.

1. Clean the area around the oil fill tube prior to removing the tube in order to prevent contaminants from falling into the valve rocker cover opening.
2. Twist the oil fill tube counterclockwise in order to unlock the tube from the valve rocker cover.
3. Lift the front of the intake manifold cover up and slide the tab out of the engine bracket.
4. Replace the oil fill tube into the valve rocker cover.

**Installation Procedure**



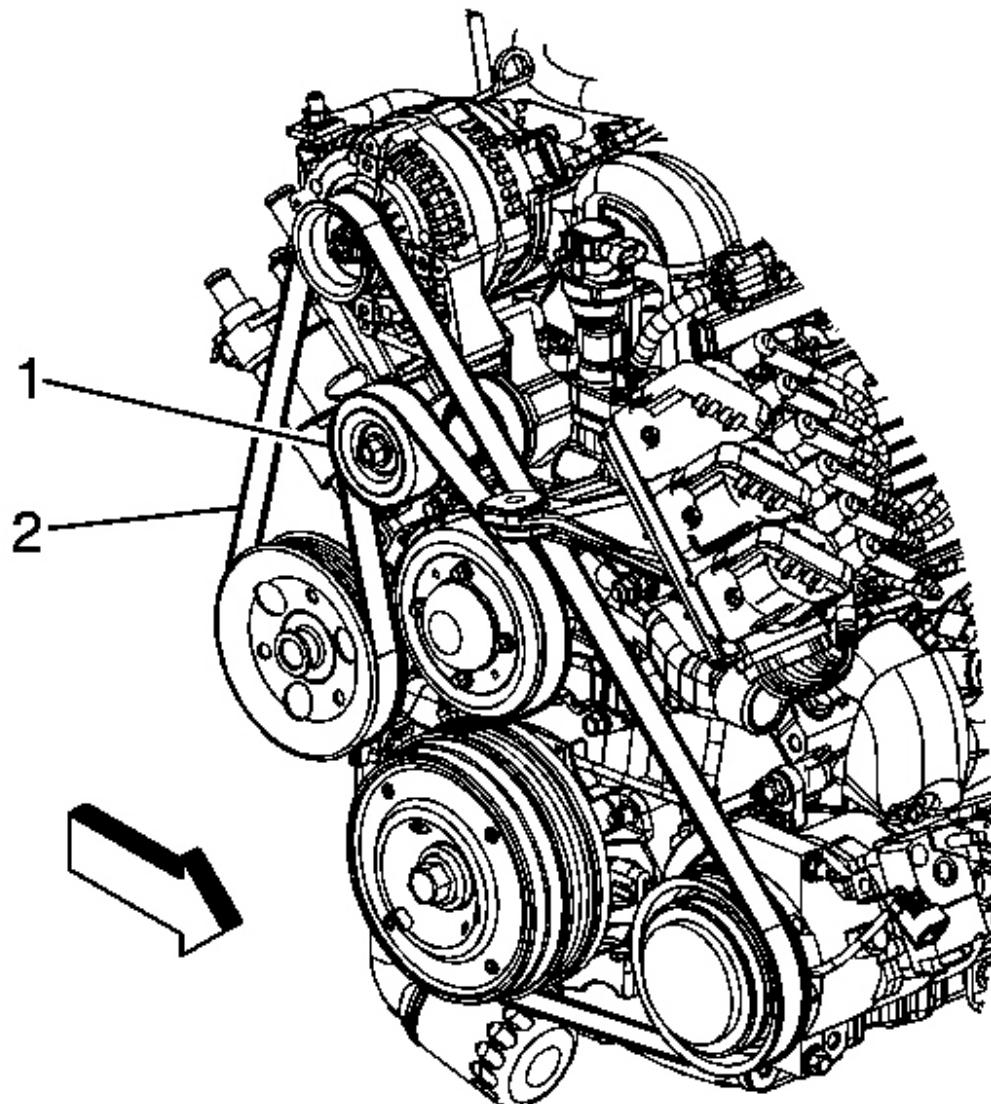
**Fig. 12: View Of Intake Manifold Cover**

Courtesy of GENERAL MOTORS CORP.

1. Remove the oil fill tube from the valve rocker cover.
2. Insert the tab on the rear of the intake manifold cover through the engine bracket.
3. Align the hole in the intake manifold cover with the oil fill tube hole in the valve rocker cover.
4. Insert the oil fill tube into the valve rocker cover and twist clockwise in order to lock the detent on the tube into the notch in the cover.

## DRIVE BELT REPLACEMENT

### Removal Procedure



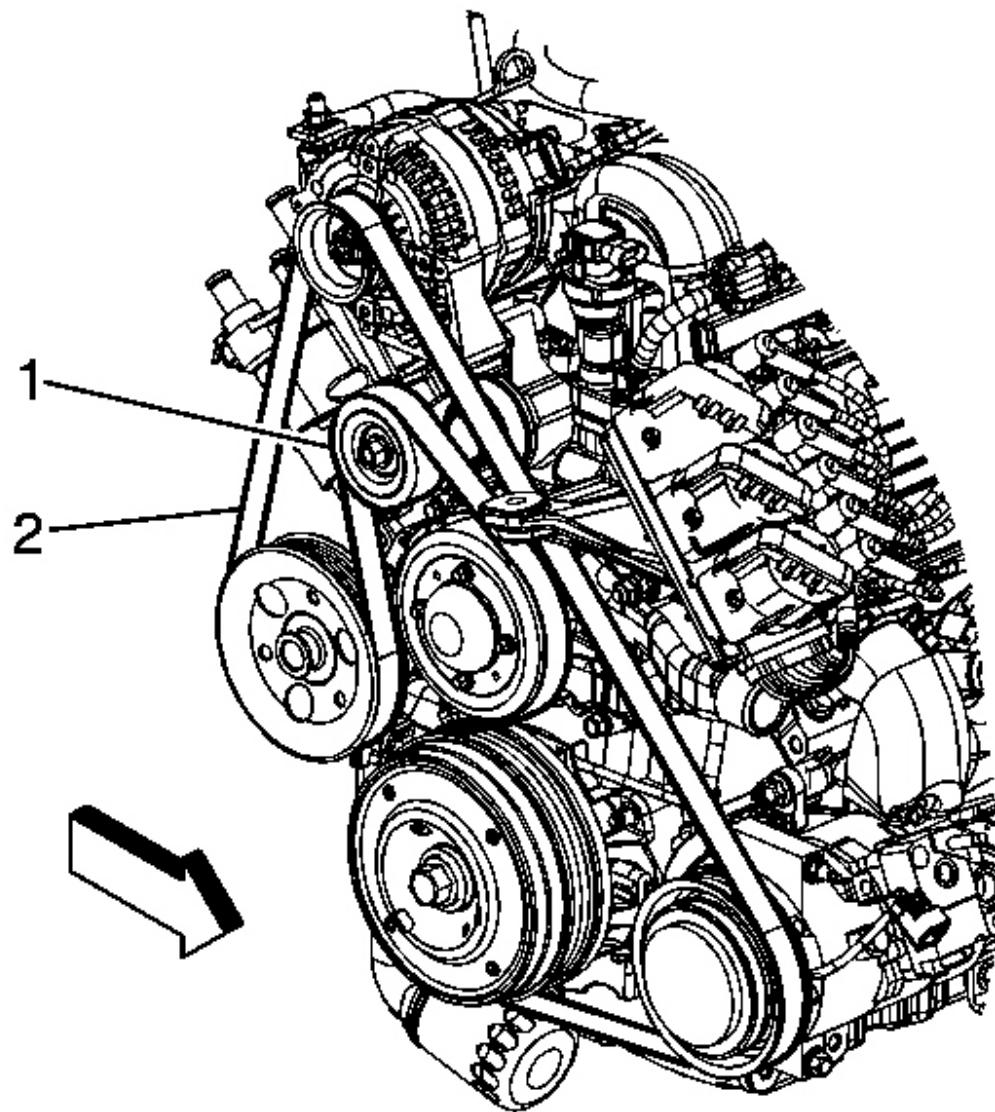
**Fig. 13: View Of Drive Belt**

Courtesy of GENERAL MOTORS CORP.

1. Using a 15 mm box end wrench on the pulley nut, rotate the drive belt tensioner (1) counterclockwise.
2. Remove the drive belt (2).

Installation Procedure

**IMPORTANT: After a NEW drive belt is installed, ensure that the mark on the drive belt tensioner is within the range indicated on the tensioner housing.**



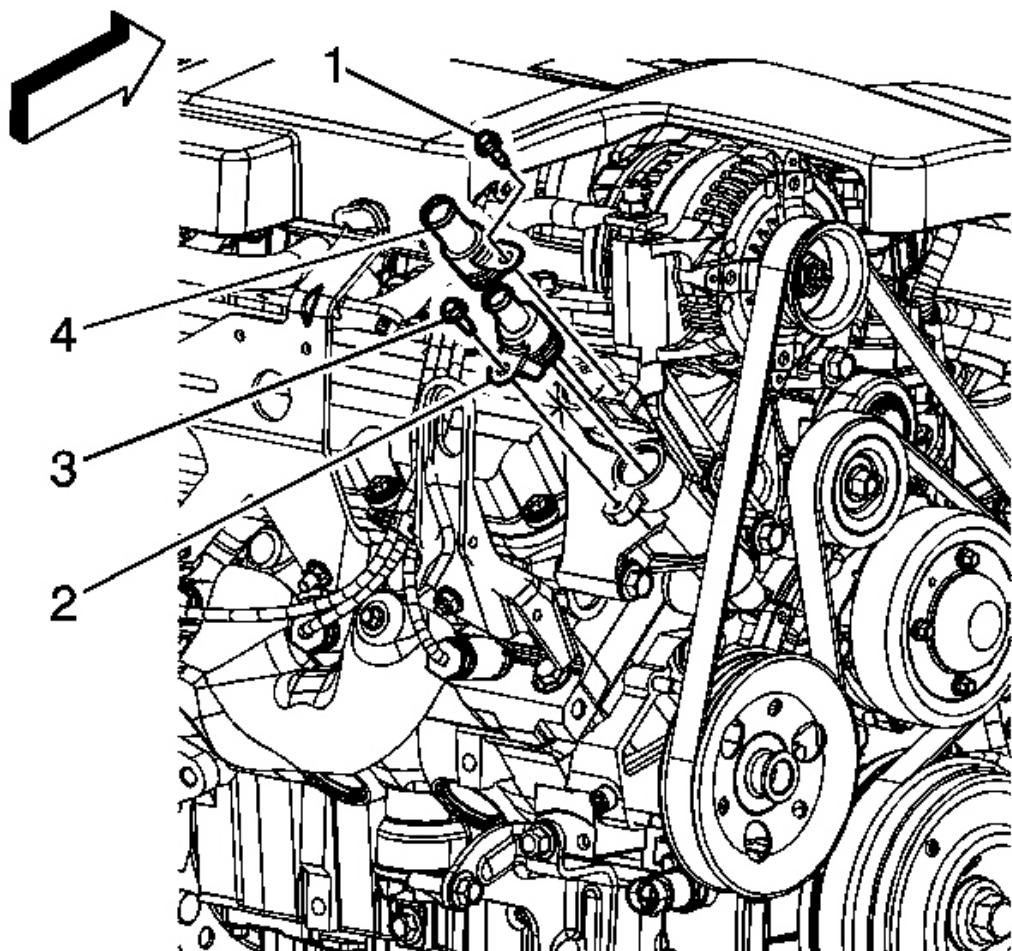
**Fig. 14: View Of Drive Belt**

**Courtesy of GENERAL MOTORS CORP.**

1. Using a 15 mm box end wrench on the pulley nut, rotate the drive belt tensioner (1) clockwise.
2. Install the drive belt (2).
3. Ensure that the drive belt is properly routed.
4. Ensure that the drive belt tensioner operates properly.

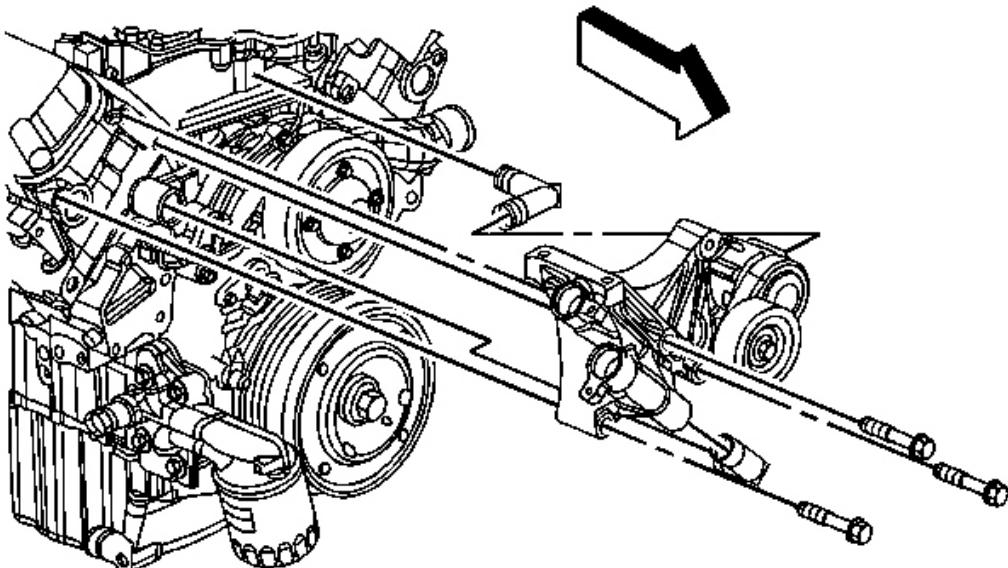
## **DRIVE BELT TENSIONER REPLACEMENT**

### **Removal Procedure**



**Fig. 15: Identifying Hose Adapter Bolts**  
Courtesy of GENERAL MOTORS CORP.

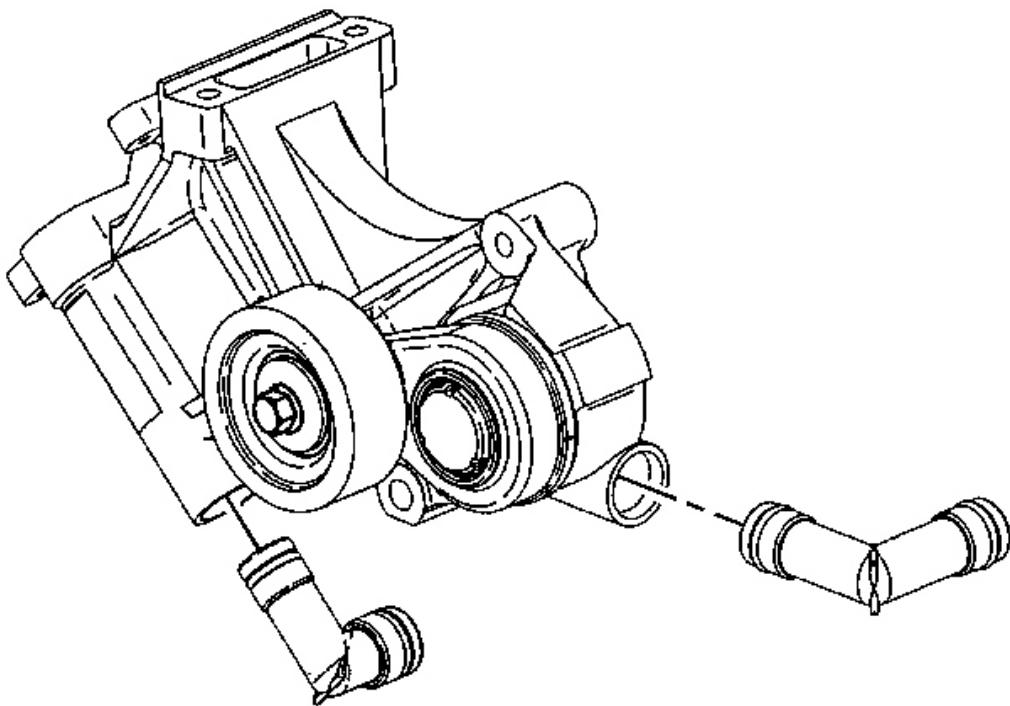
1. Drain the cooling system. Refer to [Cooling System Draining and Filling \(Static Fill\)](#) or [Cooling System Draining and Filling \(Vac-N-Fill\)](#) .
2. Remove the coolant recovery reservoir. Refer to [Coolant Recovery Reservoir Replacement](#) .
3. Remove the drive belt. Refer to [Drive Belt Replacement](#).
4. Remove the generator. Refer to [Generator Replacement \(RPO L26\)](#) or [Generator Replacement \(RPO LD8\)](#) .
5. Remove the heater inlet and outlet hose adapter bolts (1, 3). (heater hoses shown removed for clarity).
6. Remove the heater inlet (4) and outlet (2) hose adapters and reposition the hoses out of the way.



**Fig. 16: Identifying Drive Belt Tensioner Bolts**  
Courtesy of GENERAL MOTORS CORP.

7. Remove the drive belt tensioner bolts.

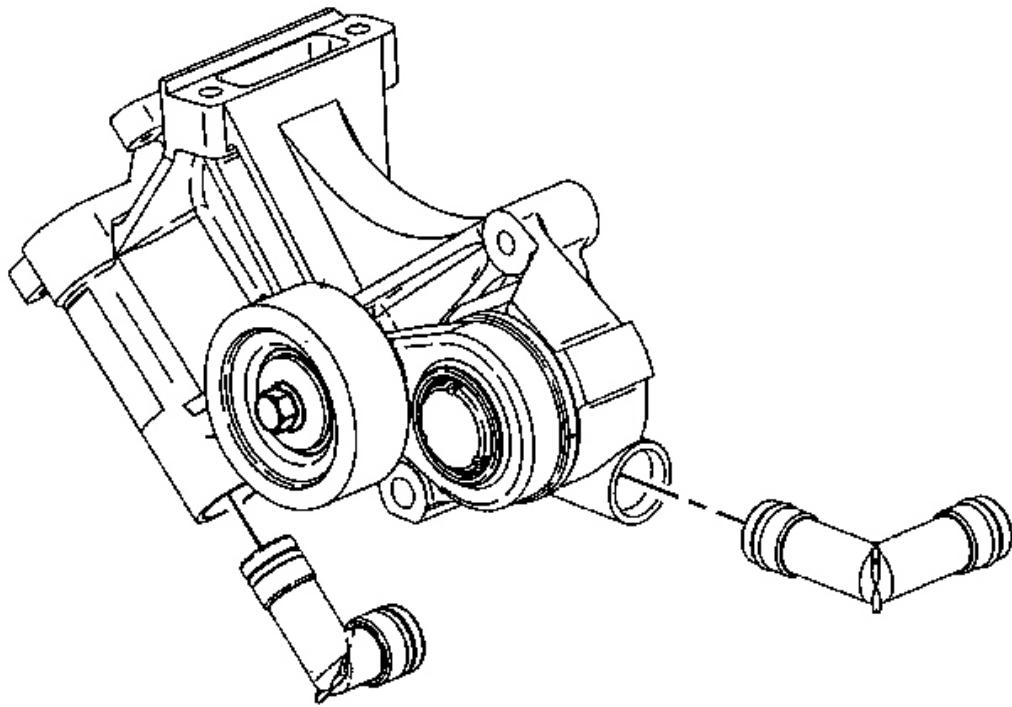
8. Remove the drive belt tensioner.



**Fig. 17: View Of Drive Belt Tensioner**  
Courtesy of GENERAL MOTORS CORP.

9. If replacing the drive belt tensioner, remove the thermostat bypass upper and lower pipes.

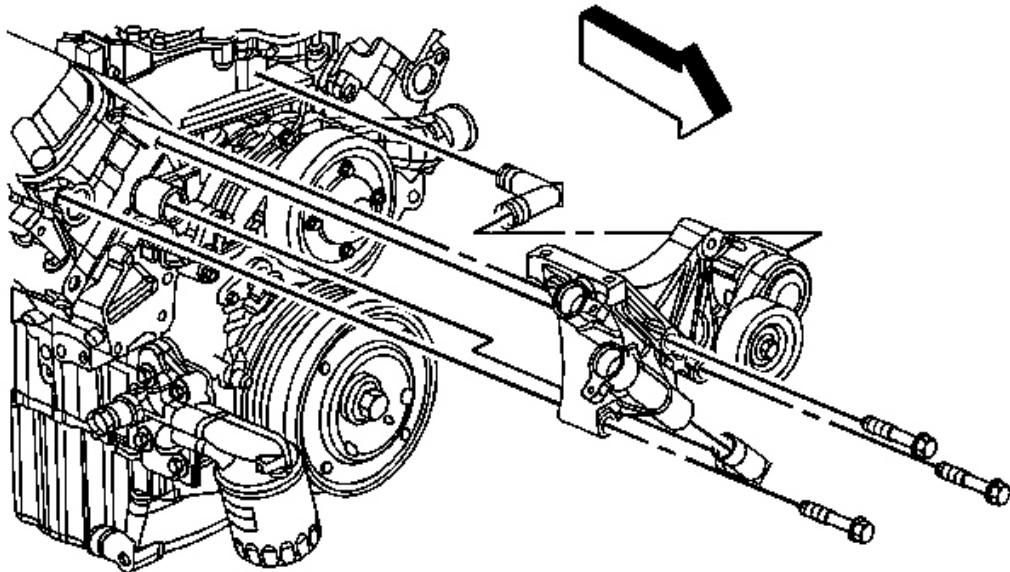
**Installation Procedure**



**Fig. 18: View Of Drive Belt Tensioner**

Courtesy of GENERAL MOTORS CORP.

1. If replacing the drive belt tensioner, lubricate the thermostat bypass upper and lower pipe seals with engine coolant and install the upper and lower pipes to the tensioner.



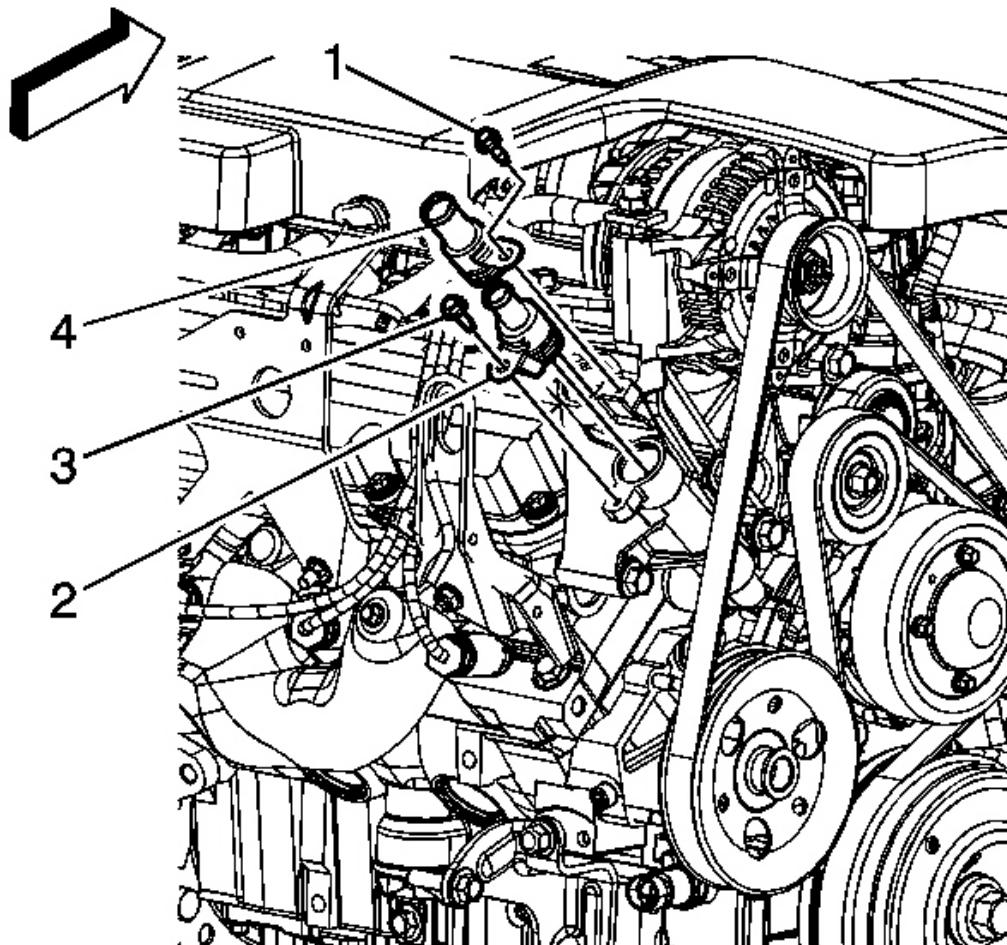
**Fig. 19: Identifying Drive Belt Tensioner Bolts**  
Courtesy of GENERAL MOTORS CORP.

2. Position the drive belt tensioner to the cylinder head.

**NOTE:** Refer to Fastener Notice .

3. Install the drive belt tensioner bolts.

**Tighten:** Tighten the bolts to 50 N.m (37 lb ft).



**Fig. 20: Identifying Hose Adapter Bolts**  
Courtesy of GENERAL MOTORS CORP.

4. Position and install the heater inlet (4) and outlet (2) hose adapters. (heater hoses shown removed for clarity).
5. Install the heater inlet and outlet hose adapter bolts (1, 3).
6. Install the generator. Refer to [Generator Replacement \(RPO L26\)](#) or [Generator Replacement \(RPO LD8\)](#) .
7. Install the drive belt. Refer to [Drive Belt Replacement](#).
8. Install the coolant recovery reservoir. Refer to [Coolant Recovery Reservoir](#)

**Replacement** .

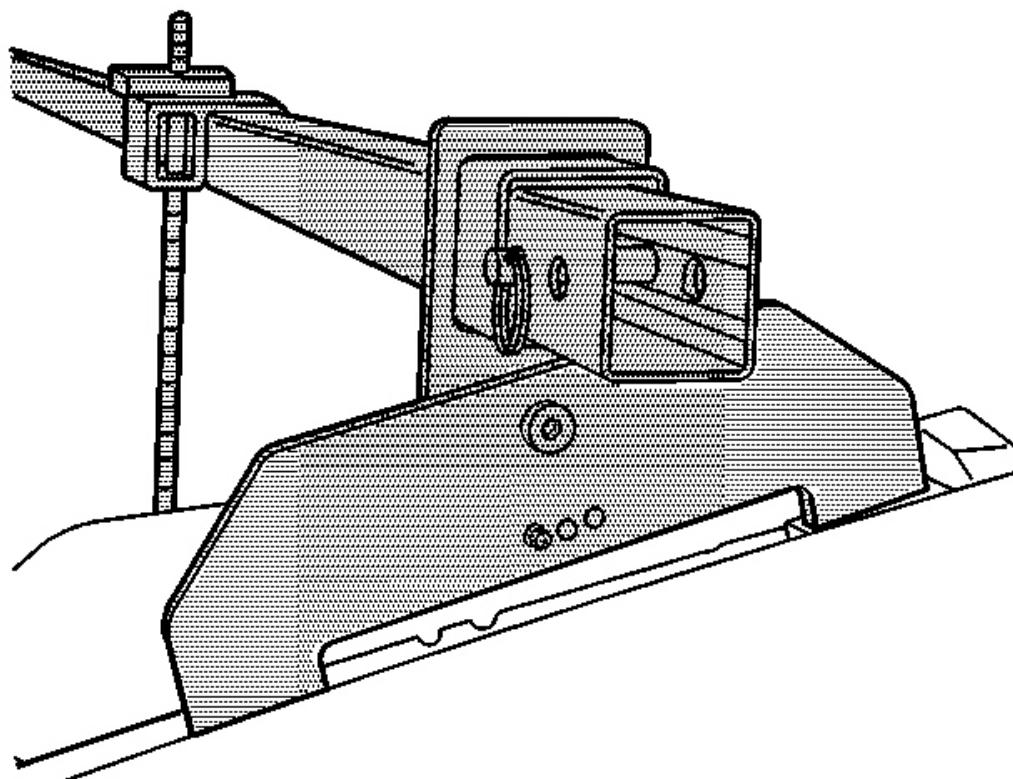
9. Fill the cooling system. Refer to [Cooling System Draining and Filling \(Static Fill\)](#) or [Cooling System Draining and Filling \(Vac-N-Fill\)](#) .

**ENGINE SUPPORT FIXTURE**

**Tools Required**

- **J 28467-B** Universal Engine Support Fixture. See [Special Tools](#).
- **J-28467-501** Engine Support Fixture Adapters

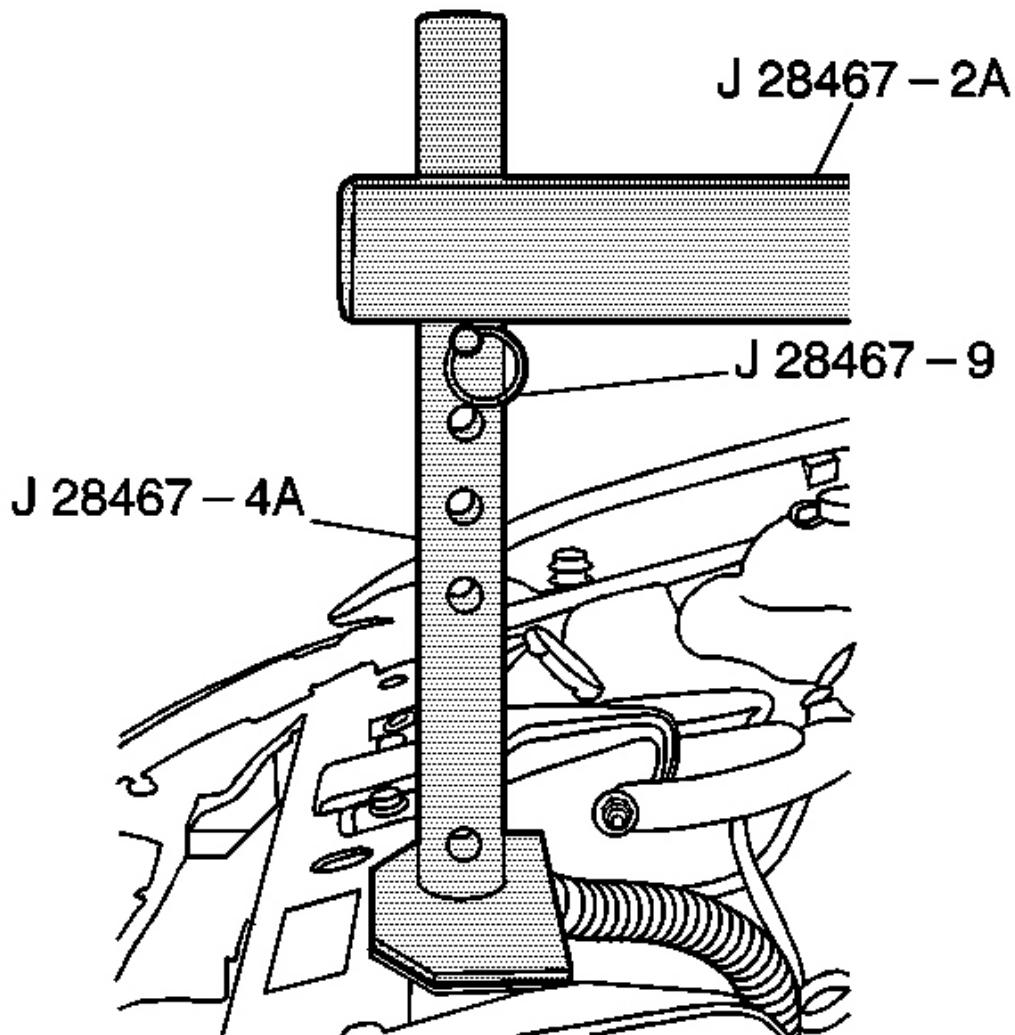
**Installation Procedure**



**Fig. 21: View Of Engine Lift Bracket**

Courtesy of GENERAL MOTORS CORP.

1. Install the **J 28467-B** and **J-28467-501** to the vehicle. See [Special Tools](#).
2. Install the radiator shelf tube J 28467-2A on top of the strut tower tube J 28467-3 over the rear engine lift bracket.

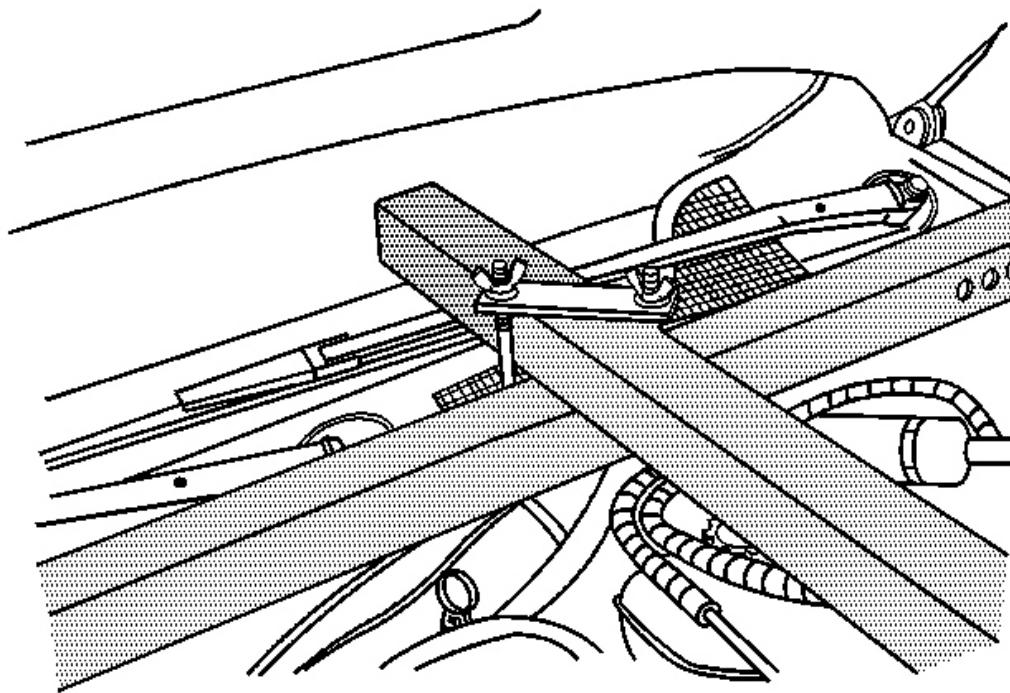


**Fig. 22: Installing Quick Release Pin J 28467-9**  
Courtesy of GENERAL MOTORS CORP.

3. Install the round tube of the front support assembly J 28467-4A through the large hole in the radiator shelf tube, J 28467-2A. The hole used in the radiator shelf tube J 28467-2A

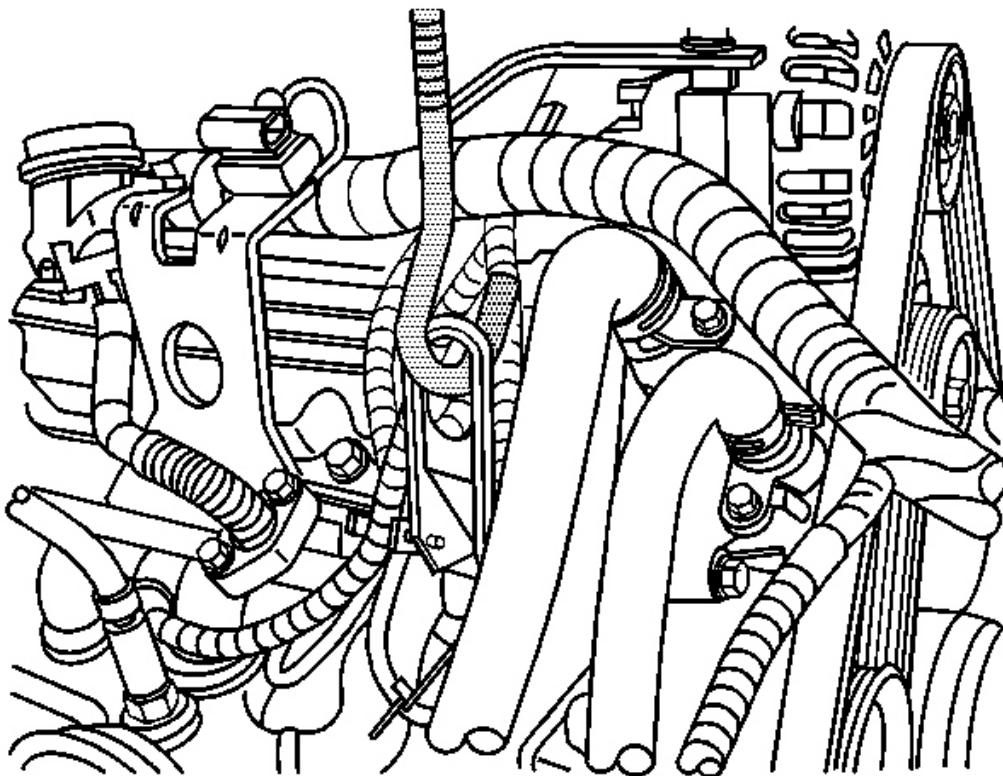
depends on the vehicle application.

4. Place the rubber padded foot of the front support assembly J 28467-4A on the upper tie bar.
5. Install the 7/16 in x 2.0 in quick release pin J 28467-9 through the hole in the front support assembly J 28467-4A in order to level the radiator shelf tube J 28467-2A.



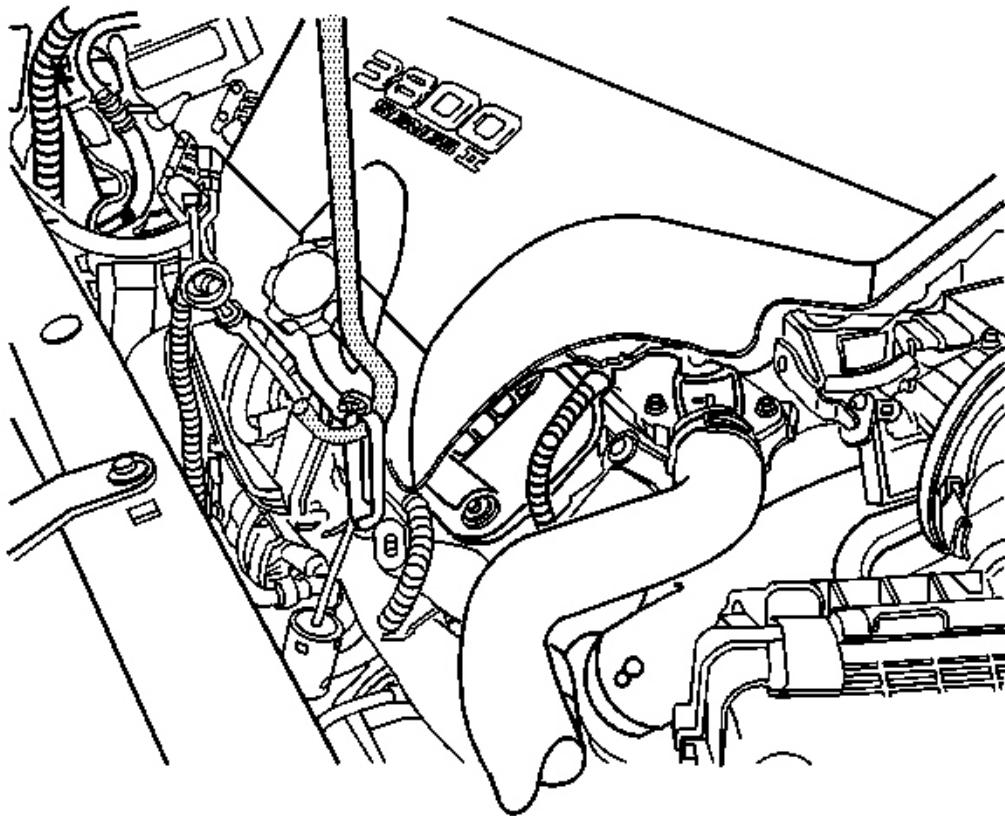
**Fig. 23: Using Cross Bracket Assembly**  
Courtesy of GENERAL MOTORS CORP.

6. Install the cross bracket assembly J 28467-1A.
7. Hand tighten the cross bracket assembly J 28467-1A wing nuts.



**Fig. 24: Installing Lift Hook Through Front Engine Lift Hook Bracket**  
Courtesy of GENERAL MOTORS CORP.

8. Install the lift hook J 28467-7A through the front engine lift hook bracket. Ensure the hook does not damage the surrounding components.

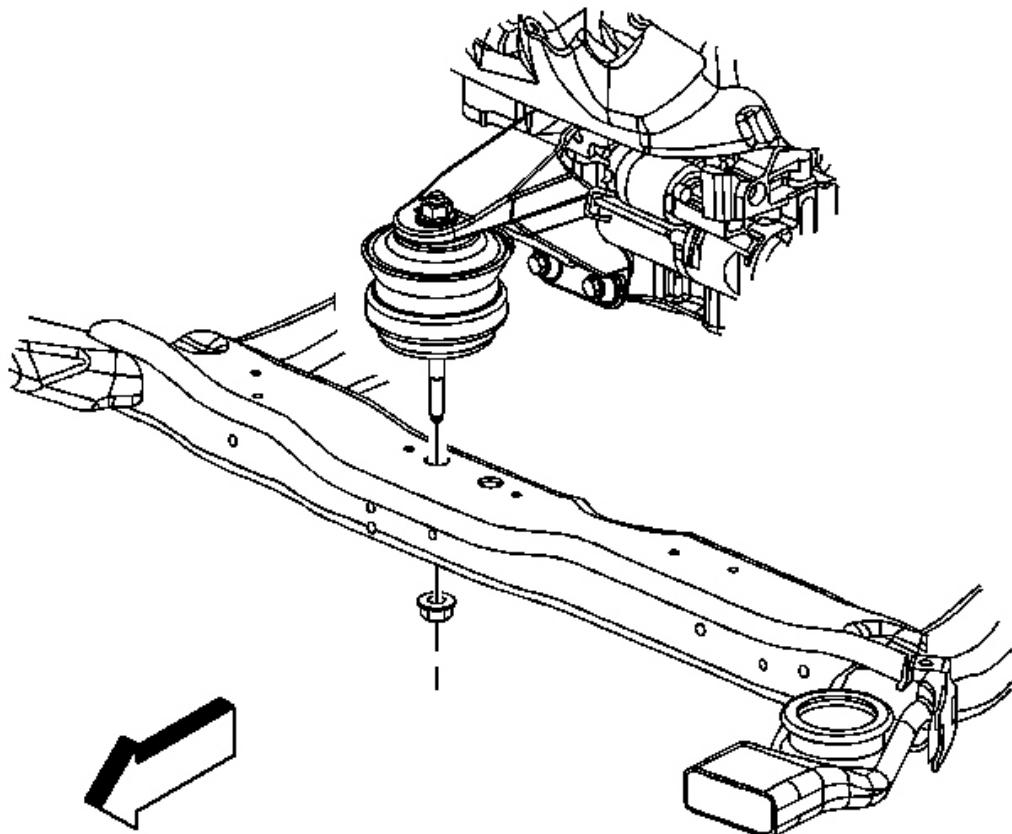


**Fig. 25: Installing Lift Hook Through Rear Engine Lift Hook Bracket**  
Courtesy of GENERAL MOTORS CORP.

9. Install the lift hook J 28467-7A through the rear engine lift hook bracket. Ensure the hook does not damage the surrounding components.
10. Hand tighten the lift hook wing nuts J 28467-34 securely to remove all slack from the engine support fixture assembly.

#### **ENGINE FRONT MOUNT REPLACEMENT**

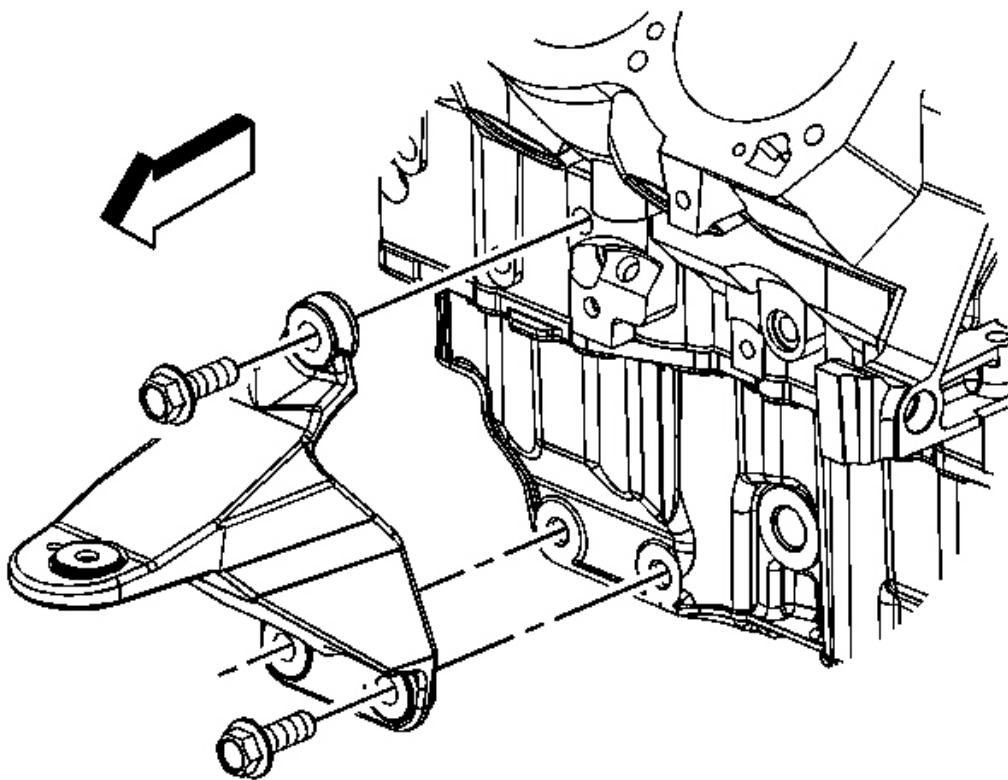
##### **Removal Procedure**



**Fig. 26: Identifying Engine Front Mount To Frame Nut**

Courtesy of GENERAL MOTORS CORP.

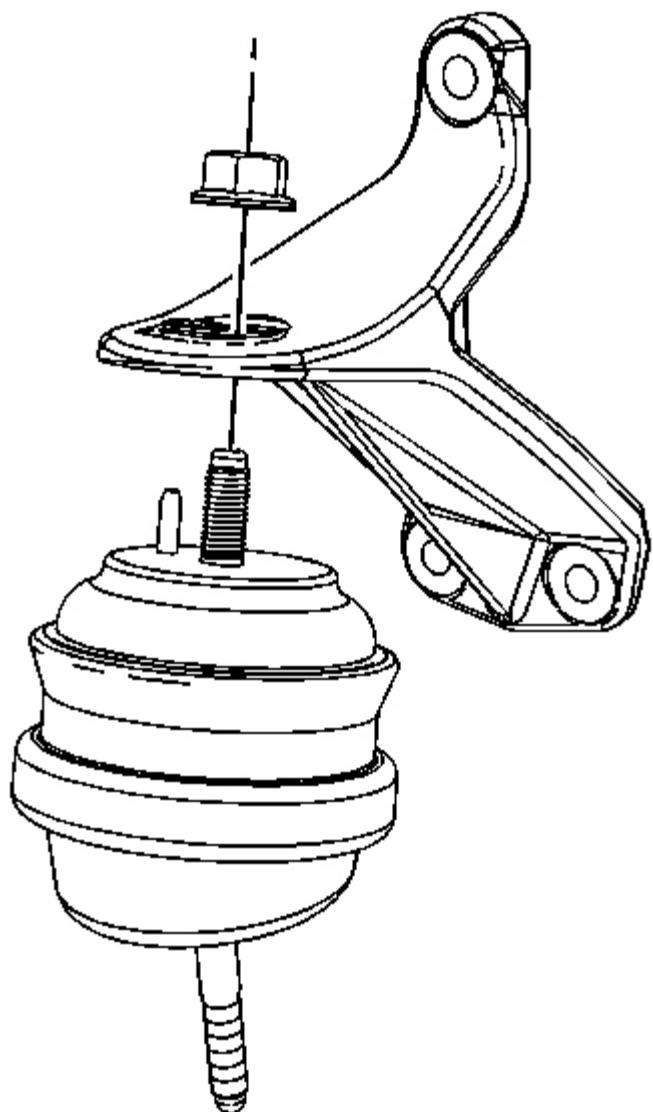
1. Remove the front air deflector. Refer to [Front Air Deflector Replacement](#) .
2. Place a suitable adjustable jack and a block of wood under the oil pan.



**Fig. 27: Identifying Engine Mount Bracket Bolts**

Courtesy of GENERAL MOTORS CORP.

3. Remove the engine mount bracket bolts.
4. Remove the engine mount to frame nut.

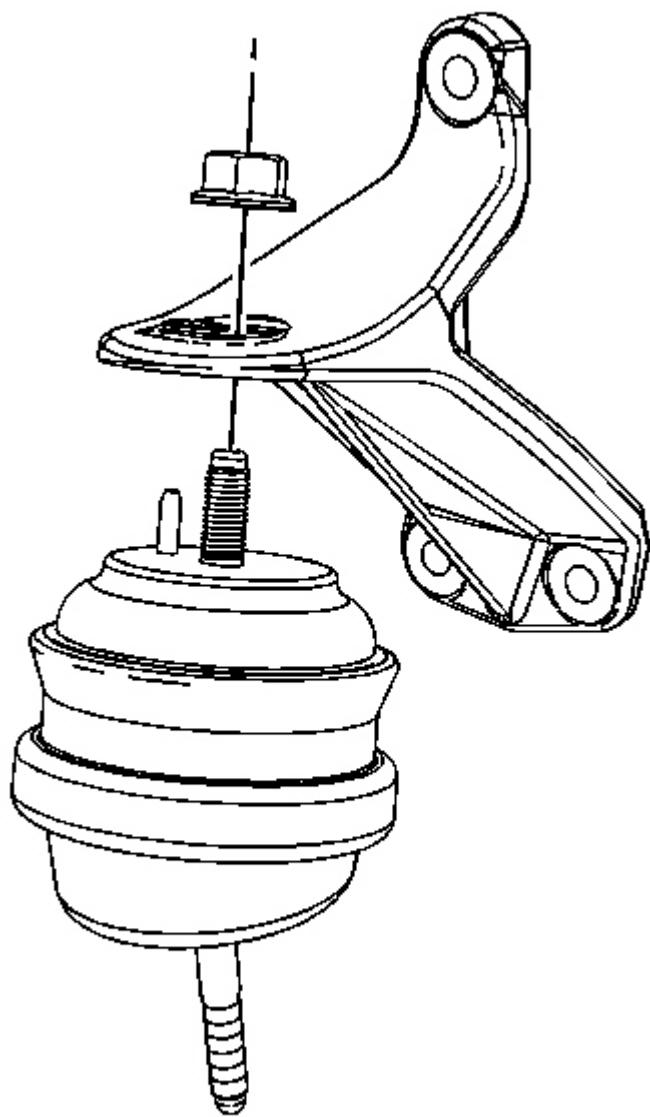


**Fig. 28: View Of Engine Mount Bracket Nut**  
Courtesy of GENERAL MOTORS CORP.

5. Remove the engine mount to bracket nut.
6. Using the adjustable jack and block of wood, raise the engine enough to remove the engine mount.

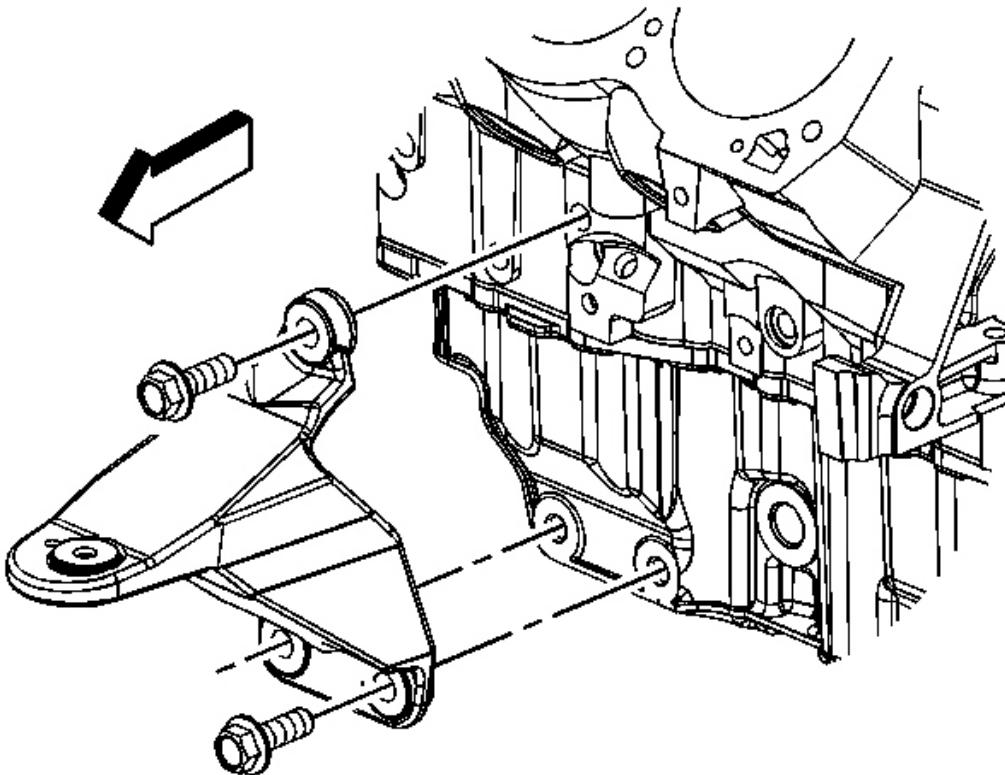
7. Remove the engine mount.

**Installation Procedure**



**Fig. 29: View Of Engine Mount Bracket Nut**  
Courtesy of GENERAL MOTORS CORP.

1. Install the engine mount into the engine bracket.



**Fig. 30: Identifying Engine Mount Bracket Bolts**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Refer to Fastener Notice .

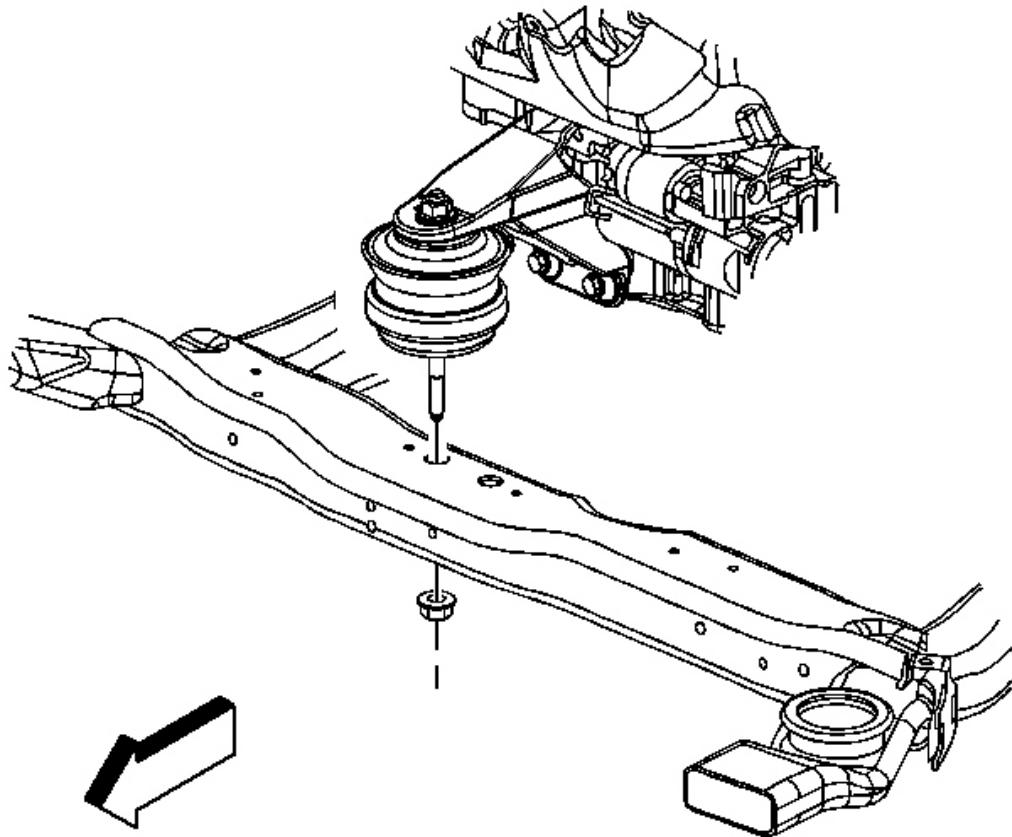
2. Install the engine mount bracket bolts.

**Tighten:** Tighten the bolts to 70 N.m (52 lb ft).

3. Install the engine mount.
4. Install the engine mount to bracket nut.

**Tighten:** Tighten the nut to 80 N.m (59 lb ft).

5. Using the adjustable jack, lower the engine.



**Fig. 31: Identifying Engine Front Mount To Frame Nut**  
Courtesy of GENERAL MOTORS CORP.

6. Install the engine mount to frame nut.

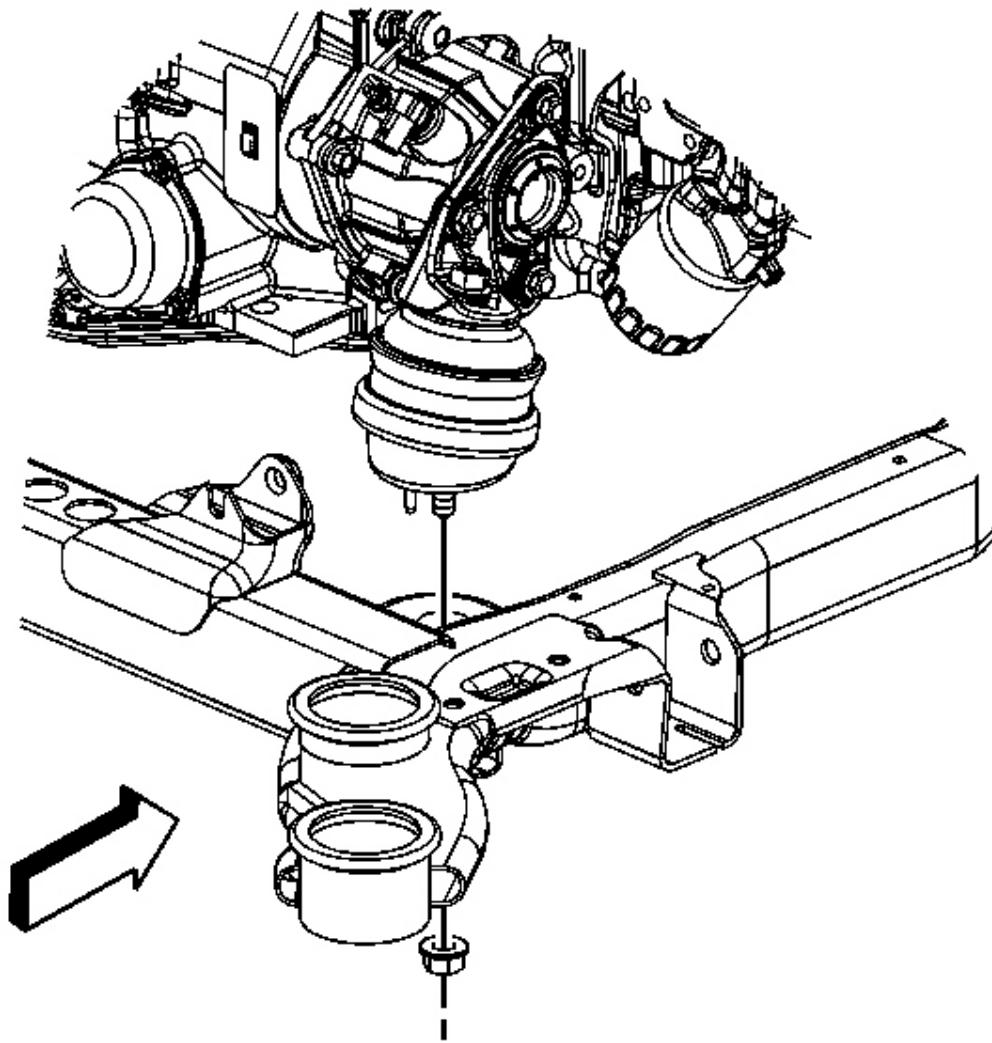
**Tighten:** Tighten the nut to 80 N.m (59 lb ft).

7. Remove the adjustable jack and block of wood from under the oil pan.
8. Install the front air deflector. Refer to [Front Air Deflector Replacement](#).

## ENGINE REAR MOUNT REPLACEMENT

### Removal Procedure

1. Remove the engine mount strut. Refer to [Engine Mount Strut Replacement](#).



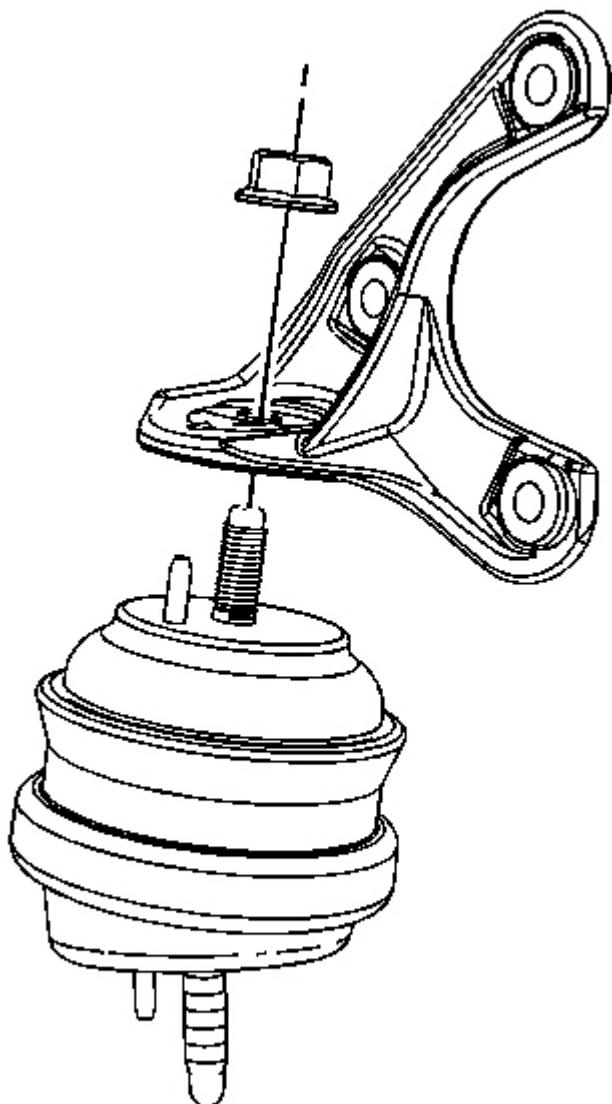
**Fig. 32: Identifying Engine Right Rear Mount To Frame Nut**  
Courtesy of GENERAL MOTORS CORP.

2. Remove the right front wheel and tire. Refer to [Tire and Wheel Removal and Installation](#).
3. Place a suitable adjustable jack under the transaxle oil pan.

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4. Remove the engine mount to frame nut.

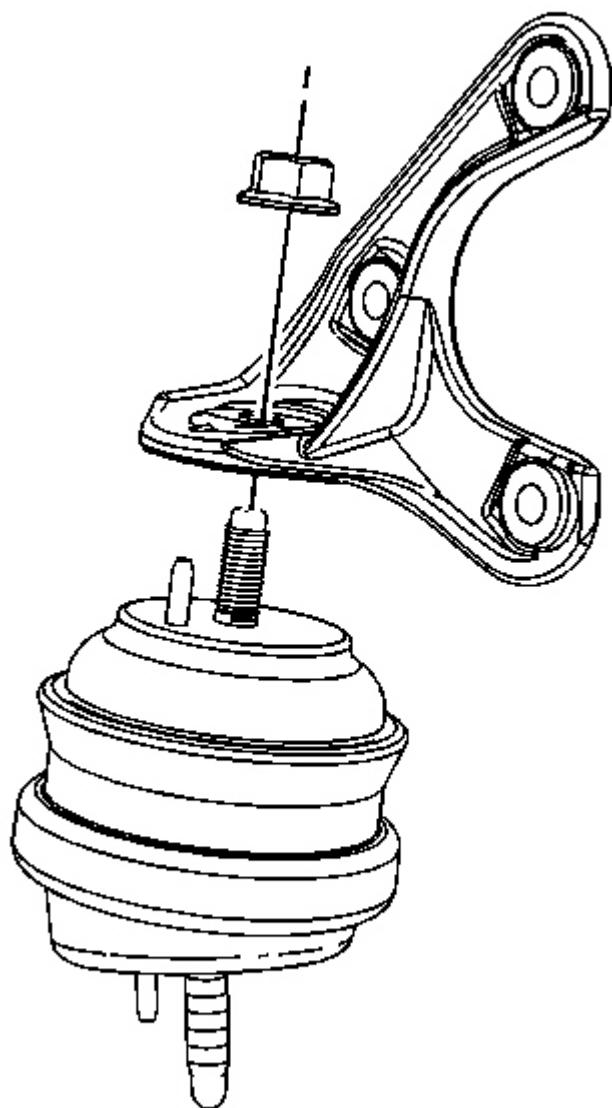


**Fig. 33: Removing/Installing Rear Engine Mount To Bracket Nut**  
**Courtesy of GENERAL MOTORS CORP.**

5. Remove the engine mount to bracket nut.

6. Using the adjustable jack and block of wood, raise the engine enough to remove the engine mount.
7. Remove the engine mount.

**Installation Procedure**



**Fig. 34: Removing/Installing Rear Engine Mount To Bracket Nut**

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**Courtesy of GENERAL MOTORS CORP.**

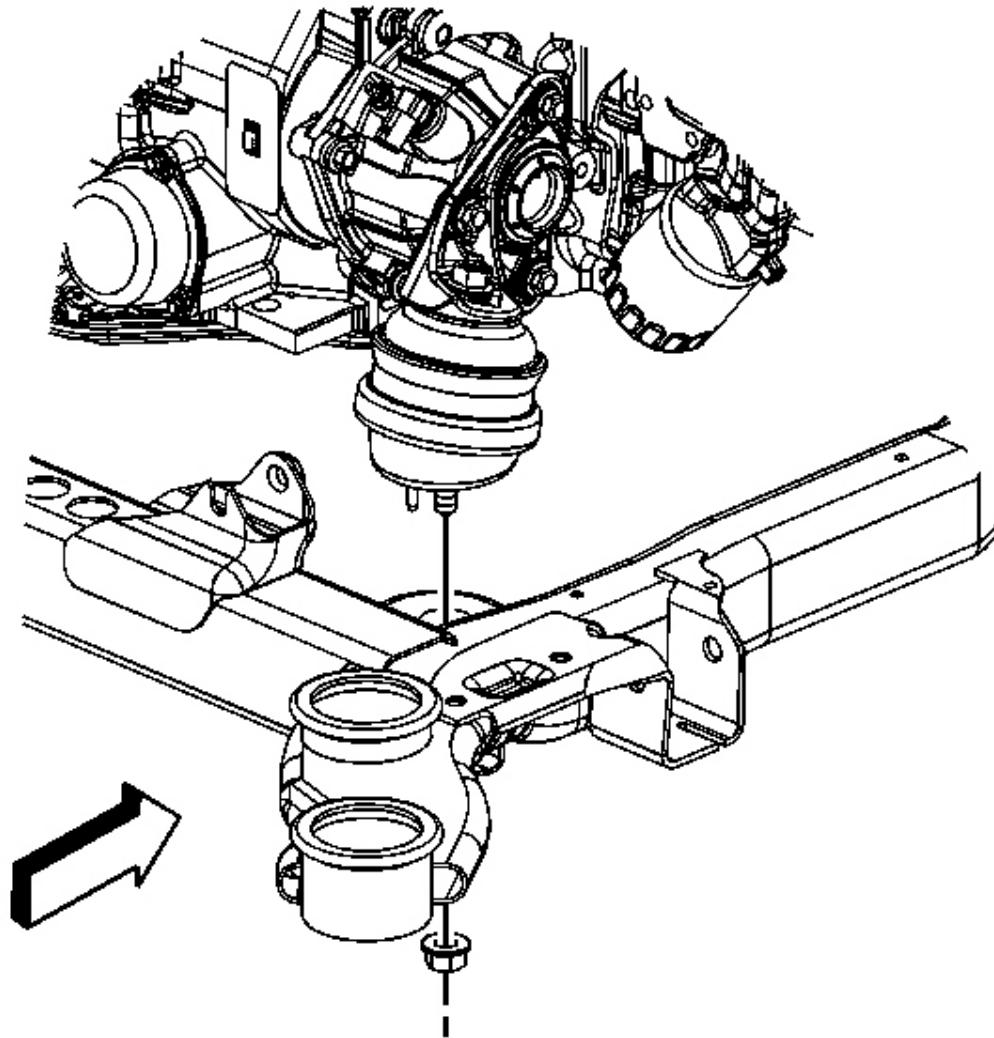
1. Install the engine mount.

**NOTE: Refer to Fastener Notice .**

2. Install the engine mount to bracket nut.

**Tighten:** Tighten the nut to 80 N.m (59 lb ft).

3. Using the adjustable jack, lower the transaxle.



**Fig. 35: Identifying Engine Right Rear Mount To Frame Nut**  
Courtesy of GENERAL MOTORS CORP.

4. Install the engine mount to frame nut.

**Tighten:** Tighten the nut to 80 N.m (59 lb ft).

5. Remove the adjustable jack and block of wood from under the transaxle oil pan.
6. Install the right front wheel and tire. Refer to [Tire and Wheel Removal and Installation](#).

7. Install the engine mount strut. Refer to [Engine Mount Strut Replacement](#).

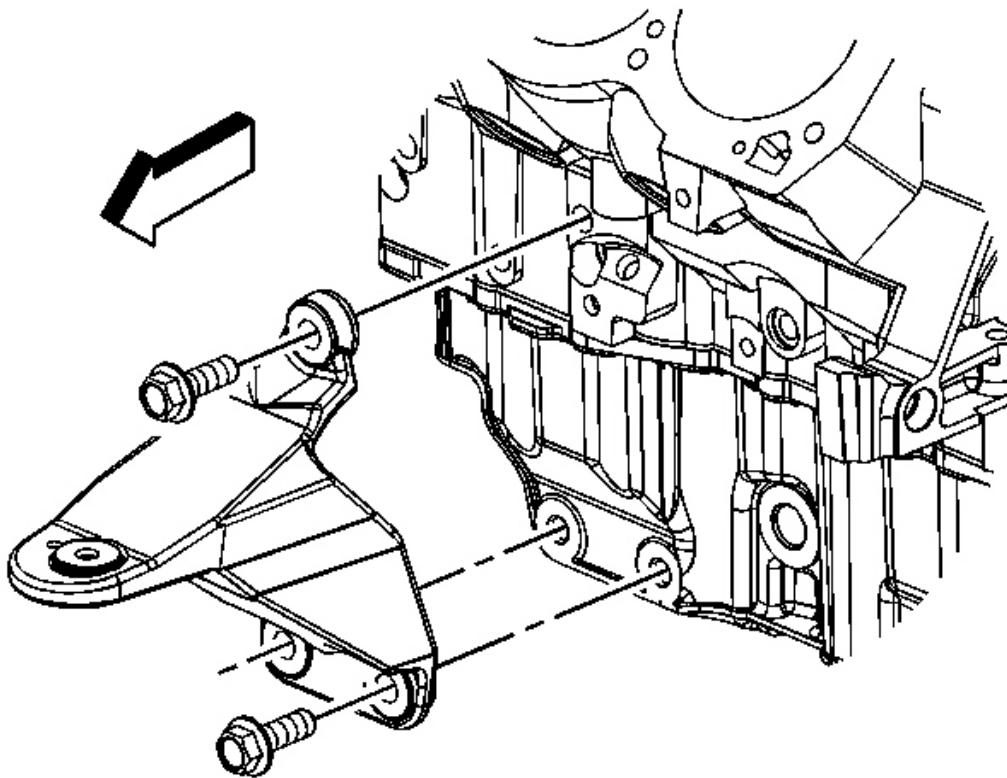
## ENGINE MOUNT INSPECTION

**IMPORTANT: Before replacing any engine mount due to suspected fluid loss, verify that the source of the fluid is the engine mount, not the engine or accessories.**

1. Install the engine support fixture. Refer to [Engine Support Fixture](#).
2. Use the support fixture in order to raise the engine and create a slight tension on the engine mount.
3. Observe the engine mount while raising the engine. Replace the engine mount if the mount exhibits any of the following conditions:
  - The hard rubber surface is covered with heat check cracks.
  - The rubber is separated from the metal plate of the engine mount.
  - The rubber is split through the center of the engine mount.
4. Refer to the following procedures when replacing the engine mounts or engine mount brackets:
  - [Engine Front Mount Replacement](#)
  - [Engine Rear Mount Replacement](#)
  - [Engine Front Mount Bracket Replacement](#)
  - [Engine Rear Mount Bracket Replacement](#)
5. If there is movement between the metal plate of the engine mount and its attaching points, lower the engine on the engine mount. Tighten the bolts or nuts attaching the engine mount to the frame or engine mount bracket. Refer to [Fastener Tightening Specifications](#).
6. For information on the transaxle mounts, refer to [Transmission Mount Inspection](#).

## ENGINE FRONT MOUNT BRACKET REPLACEMENT

### Removal Procedure

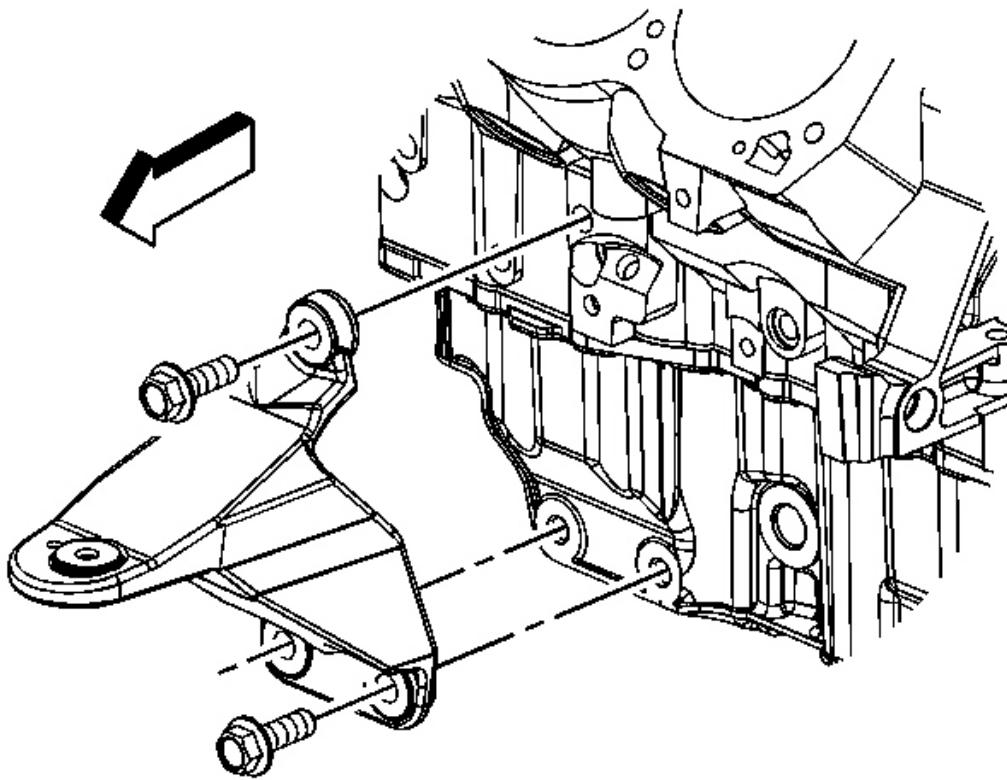


**Fig. 36: View Of Engine Mount Bracket & Bolts**

Courtesy of GENERAL MOTORS CORP.

1. Remove the engine mount. Refer to [Engine Front Mount Replacement](#).
2. Remove the engine mount bracket bolts.
3. Remove the engine mount bracket.

#### Installation Procedure



**Fig. 37: View Of Engine Mount Bracket & Bolts**  
Courtesy of GENERAL MOTORS CORP.

1. Position the engine mount bracket to the engine.

**NOTE:** Refer to Fastener Notice .

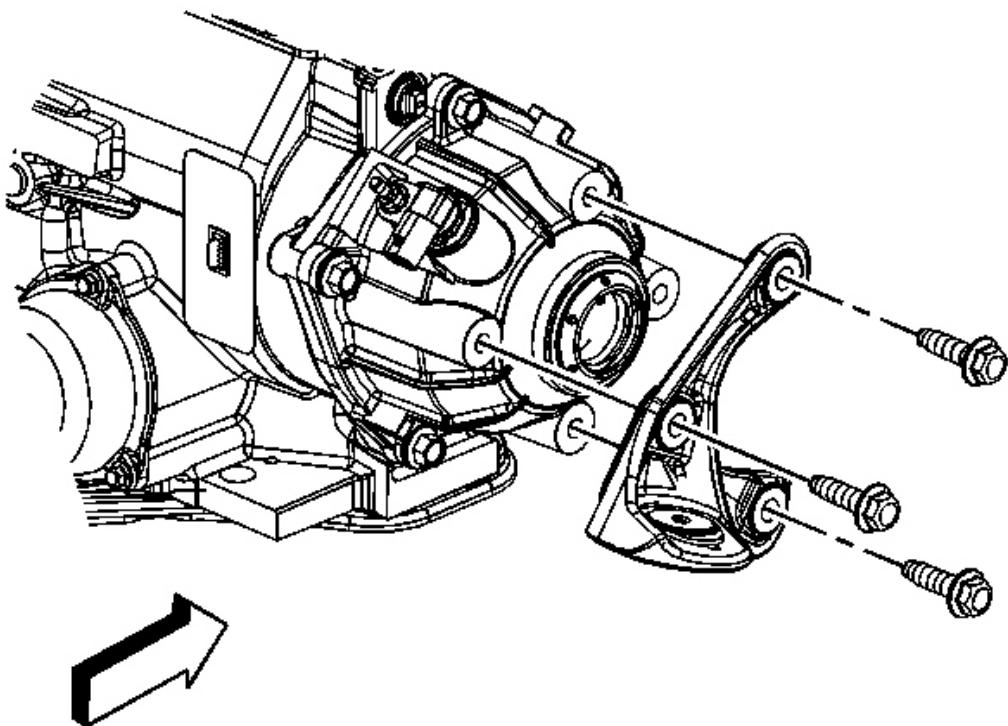
2. Install the engine mount bracket bolts.

**Tighten:** Tighten the bolts to 70 N.m (52 lb ft).

3. Install the engine mount. Refer to Engine Front Mount Replacement.

#### **ENGINE REAR MOUNT BRACKET REPLACEMENT**

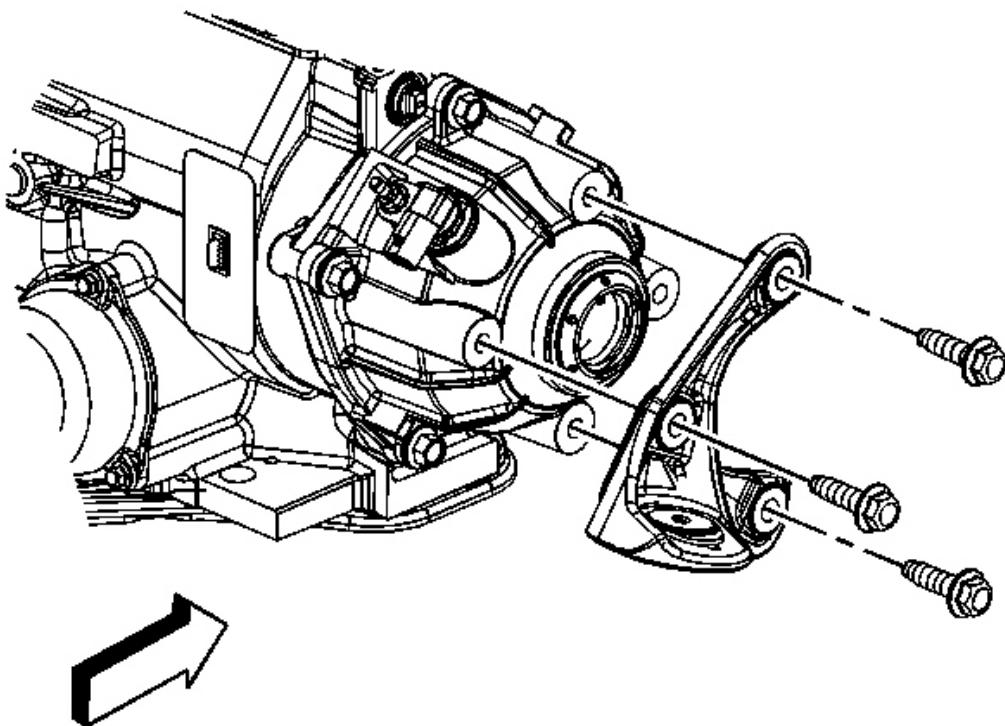
##### **Removal Procedure**



**Fig. 38: View Of Rear Engine Mount Bracket & Bolts**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine mount. Refer to [Engine Rear Mount Replacement](#).
2. Remove the engine mount bracket bolts.
3. Remove the engine mount bracket.

**Installation Procedure**



**Fig. 39: View Of Rear Engine Mount Bracket & Bolts**

Courtesy of GENERAL MOTORS CORP.

1. Position the engine mount bracket to the transaxle.

**NOTE: Refer to Fastener Notice .**

2. Install the engine mount bracket bolts.

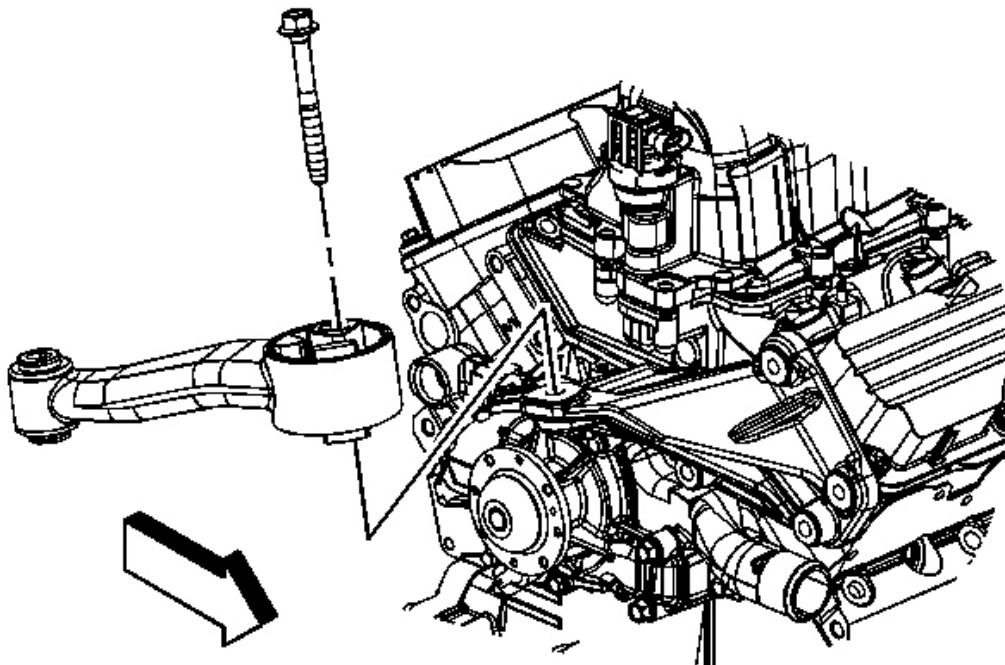
**Tighten:** Tighten the bolts to 50 N.m (37 lb ft).

3. Install the engine mount. Refer to Engine Rear Mount Replacement.

#### ENGINE AND TRANSMISSION MOUNT BALANCING - ALL MOUNTS

**IMPORTANT: Follow the balance procedure in the order listed in the following steps. Powertrain mounts must be tightened in sequence.**

**Procedure**



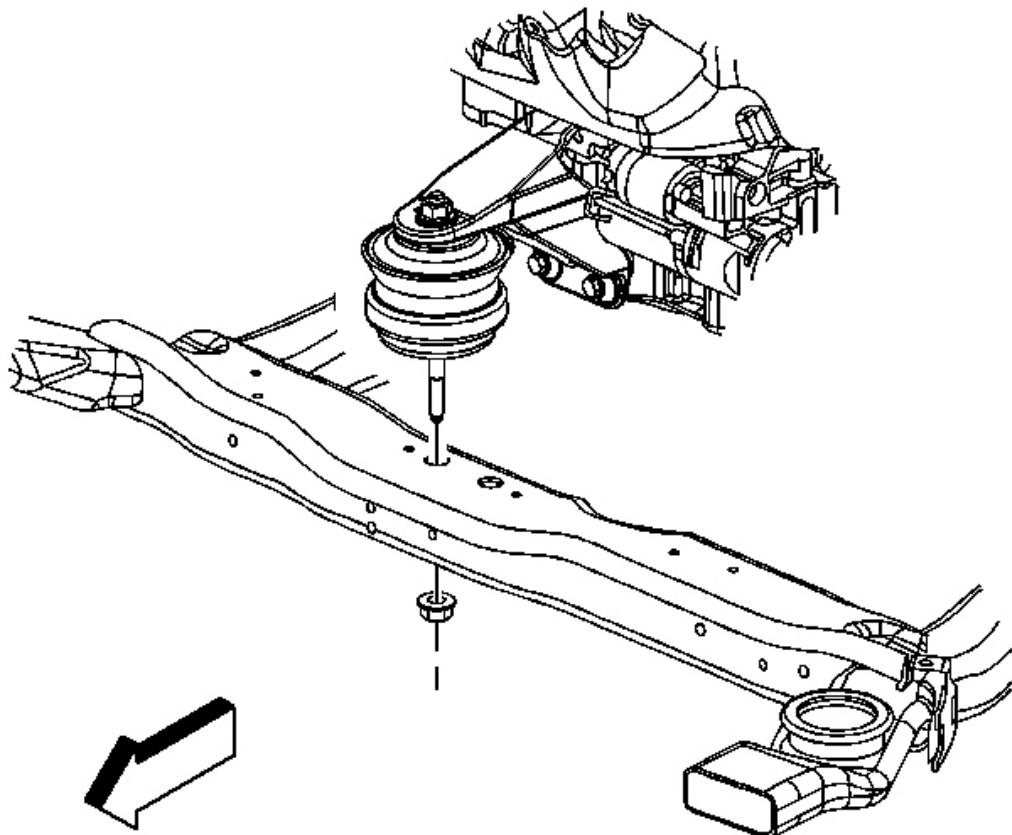
**Fig. 40: Identifying Engine Mount Strut Bolt**

Courtesy of GENERAL MOTORS CORP.

1. Remove the engine mount strut bolt.
2. Install the engine support fixture. Refer to [Engine Support Fixture](#).
3. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).

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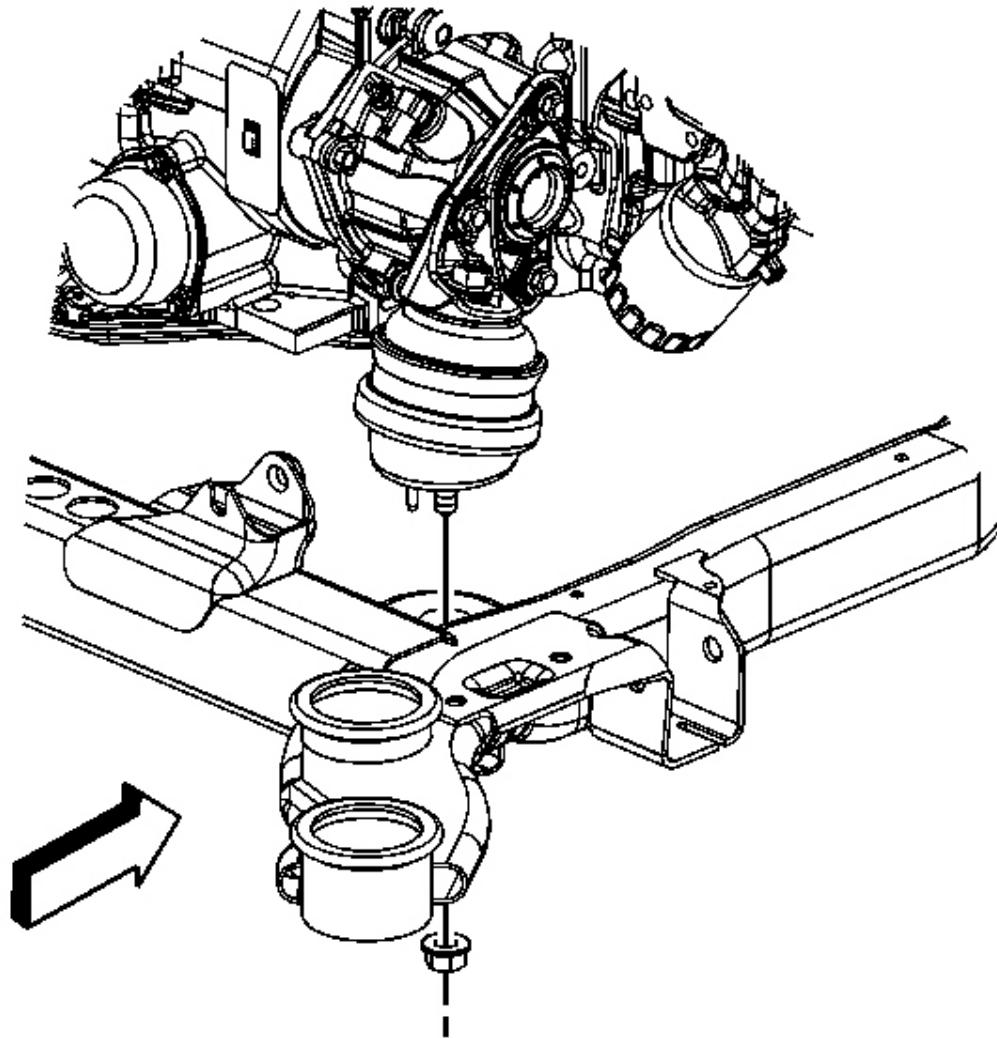
**Fig. 41: View Of Engine Front Mount To Frame Nut**

**Courtesy of GENERAL MOTORS CORP.**

4. Loosen but DO NOT REMOVE the front engine mount lower nut.

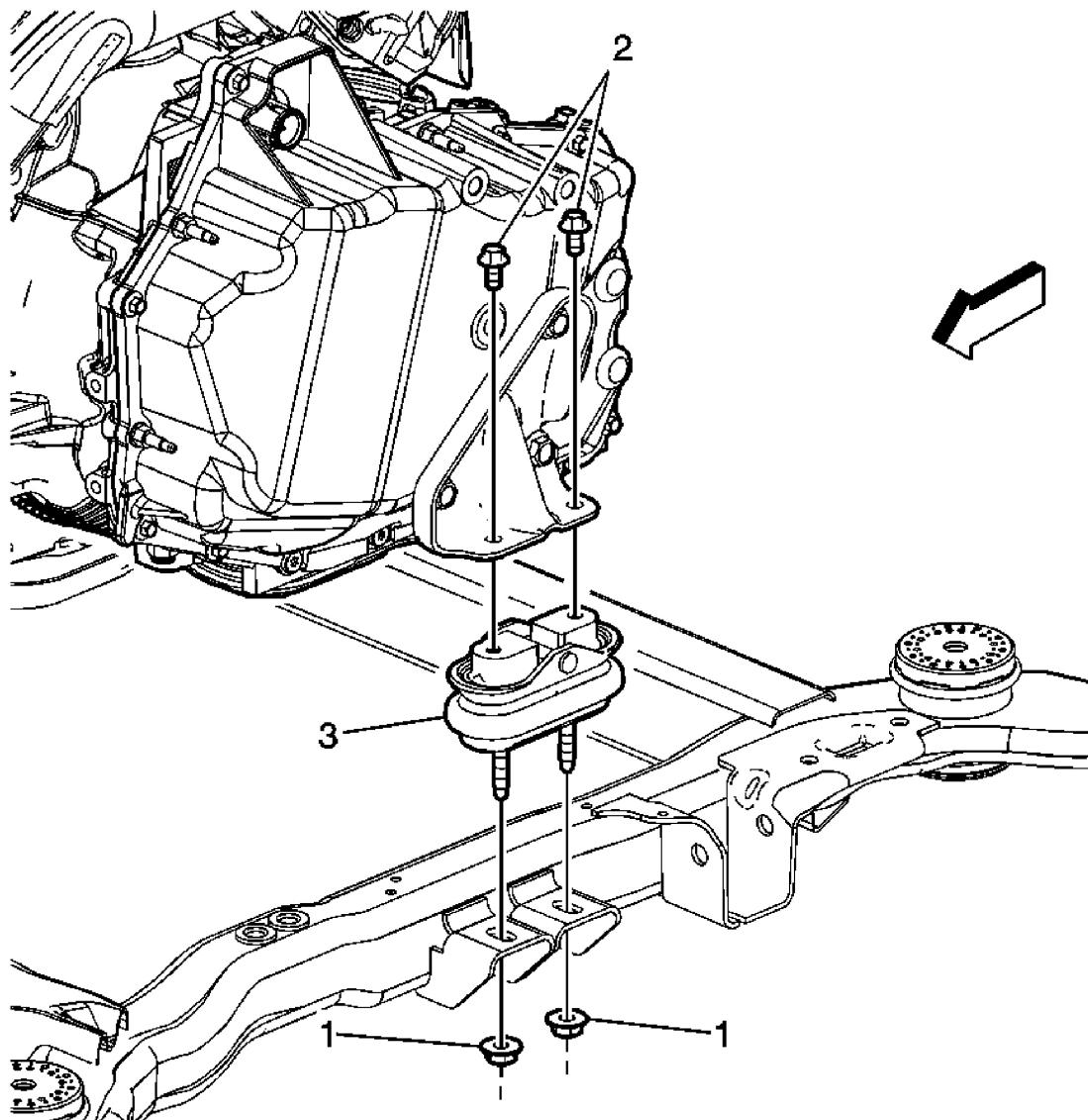
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**Fig. 42: Identifying Engine Rear Mount To Frame Nut**  
Courtesy of GENERAL MOTORS CORP.

5. Loosen but DO NOT REMOVE the rear engine mount lower nut.



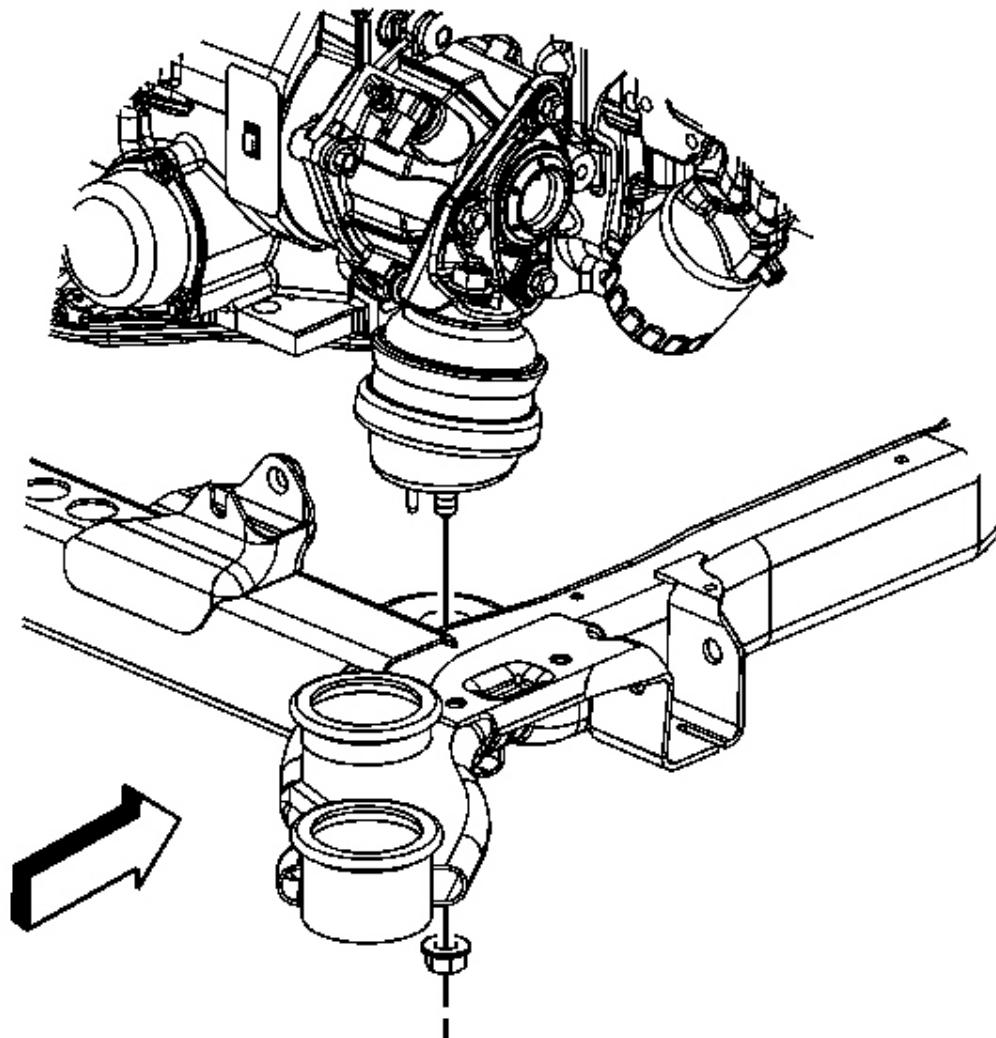
**Fig. 43: Identifying Transmission Mount To Frame Nut**

Courtesy of GENERAL MOTORS CORP.

6. Loosen but DO NOT REMOVE the transmission mount to frame nuts (1).
7. Lower the vehicle.

**IMPORTANT: Confirm that each mount has achieved zero load.**

8. Using the engine support fixture, raise the powertrain mounts off of the cradle.
9. Reset the powertrain on the frame and remove engine support fixture.
10. Raise the vehicle.



**Fig. 44: Identifying Engine Rear Mount To Frame Nut**  
Courtesy of GENERAL MOTORS CORP.

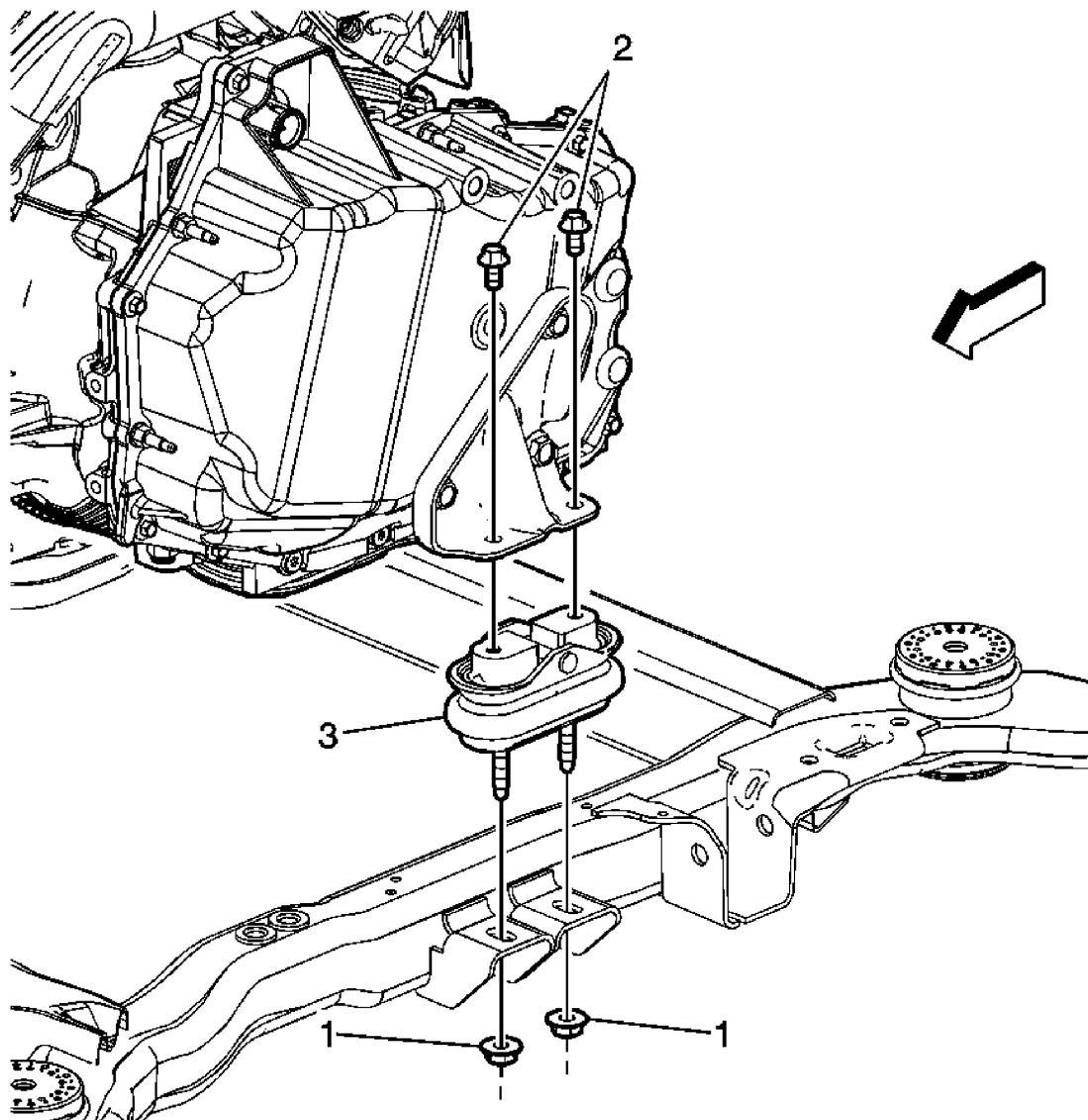
**NOTE:** Refer to Fastener Notice .

11. Install the rear engine mount to cradle nut.

**Tighten:** Tighten the nut to 80 N.m (59 lb ft).

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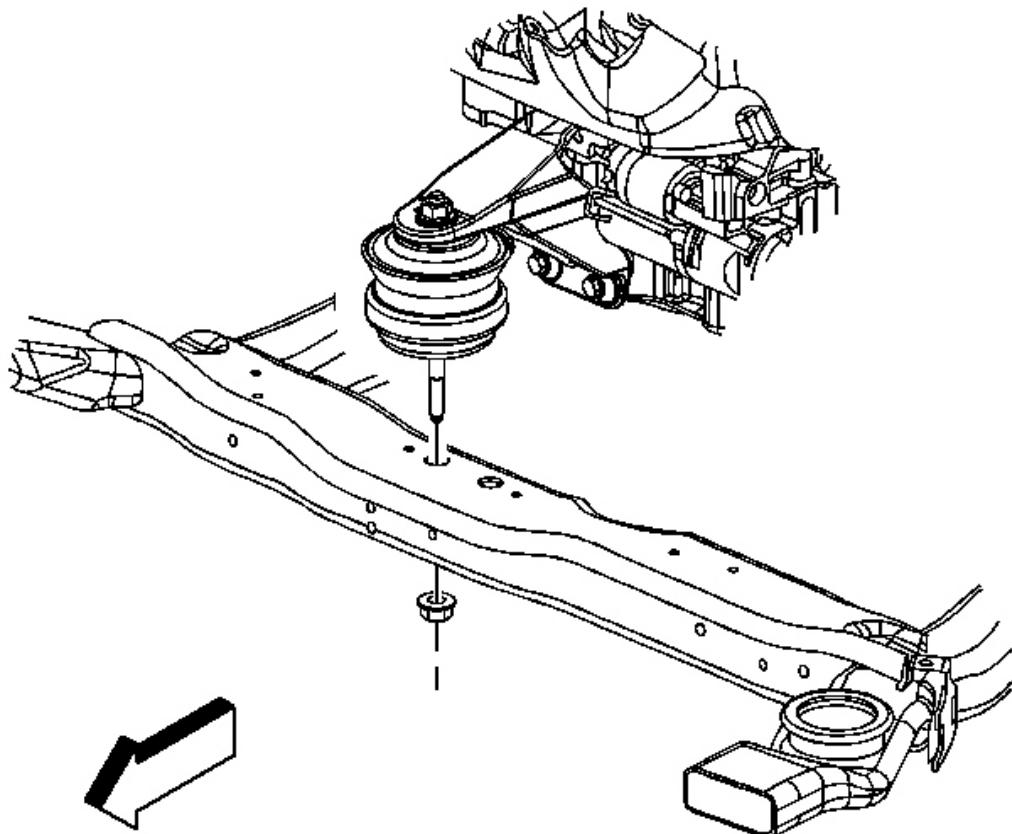
**Fig. 45: View Of Rear Transmission Mount To Cradle Nuts**  
Courtesy of GENERAL MOTORS CORP.

12. Install the rear transmission mount to cradle nuts.

**Tighten:** Tighten the nuts to 50 N.m (37 lb ft).

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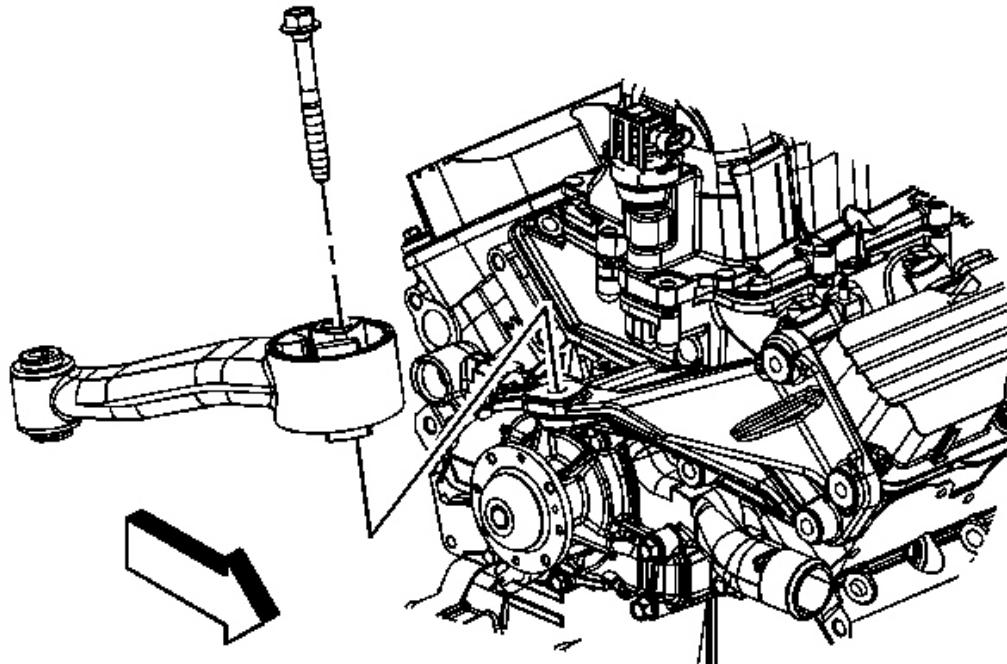
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**Fig. 46: View Of Engine Front Mount To Frame Nut**  
Courtesy of GENERAL MOTORS CORP.

13. Install the front engine mount nut.

**Tighten:** Tighten the nut to 80 N.m (59 lb ft).



**Fig. 47: Identifying Engine Mount Strut Bolt**  
Courtesy of GENERAL MOTORS CORP.

14. Lower the vehicle.

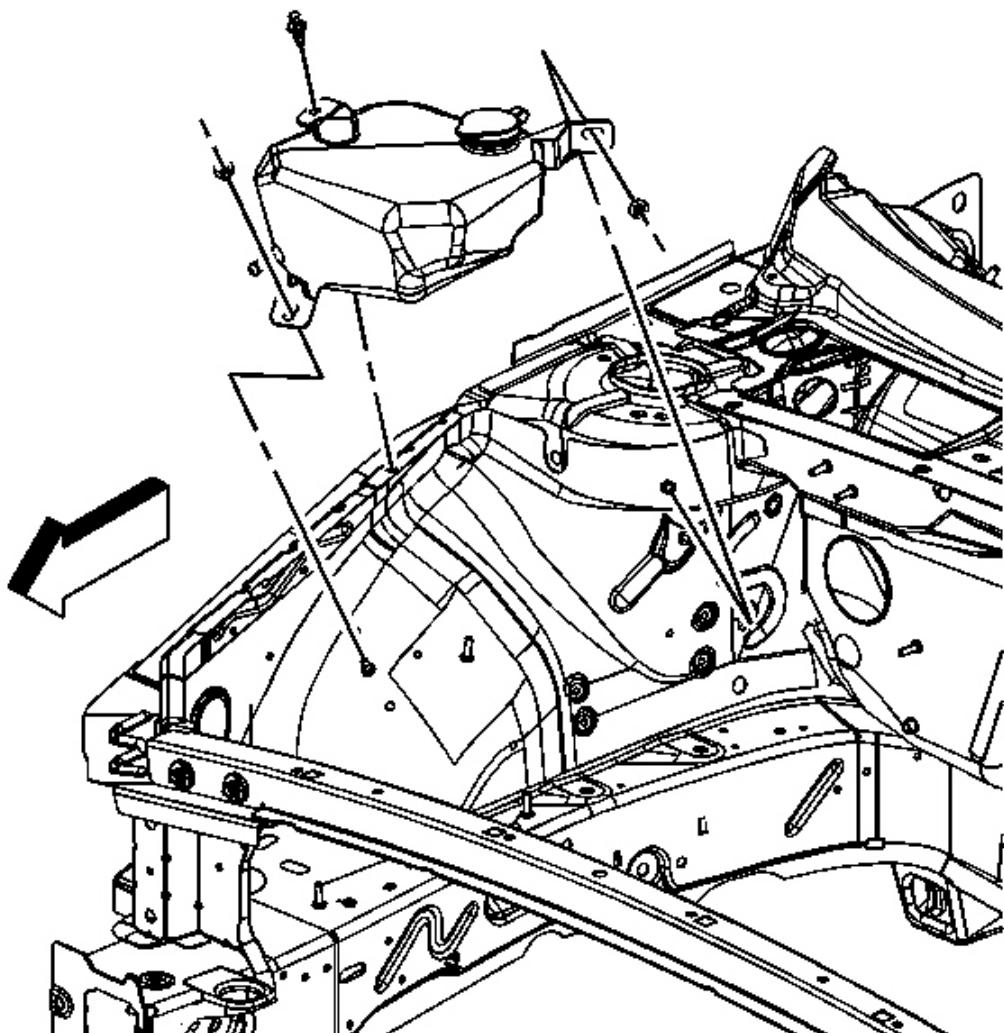
**IMPORTANT:** The torque strut should have zero preload when the transaxle selector is in Park on a level surface. Both of the bushing sleeves on the torque strut are slotted to accommodate build variation. The torque strut bolt should easily thread into the engine side bracket without side load. If the strut is preloaded and side loads the forward bolt, loosen the rear torque strut nut to the body side bracket, reposition the strut to avoid preloading.

15. Install the torque strut bolt.

**Tighten:** Tighten the bolt and nut to 70 N.m (52 lb ft).

## ENGINE MOUNT STRUT REPLACEMENT

### Removal Procedure



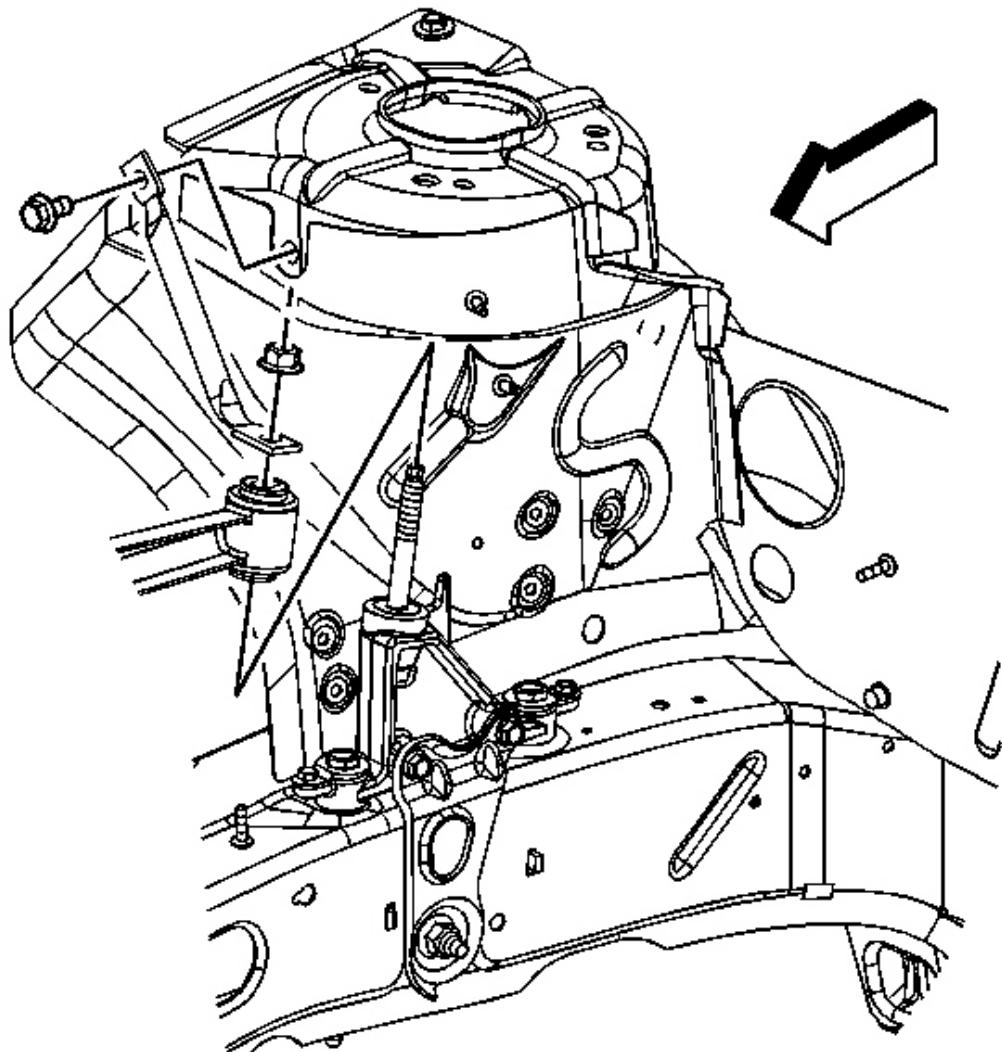
**Fig. 48: Identifying Coolant Reservoir & Nuts**

Courtesy of GENERAL MOTORS CORP.

1. Remove the coolant recovery reservoir nuts and push pin retainer.
2. Remove the recovery reservoir from the studs and position the reservoir aside.

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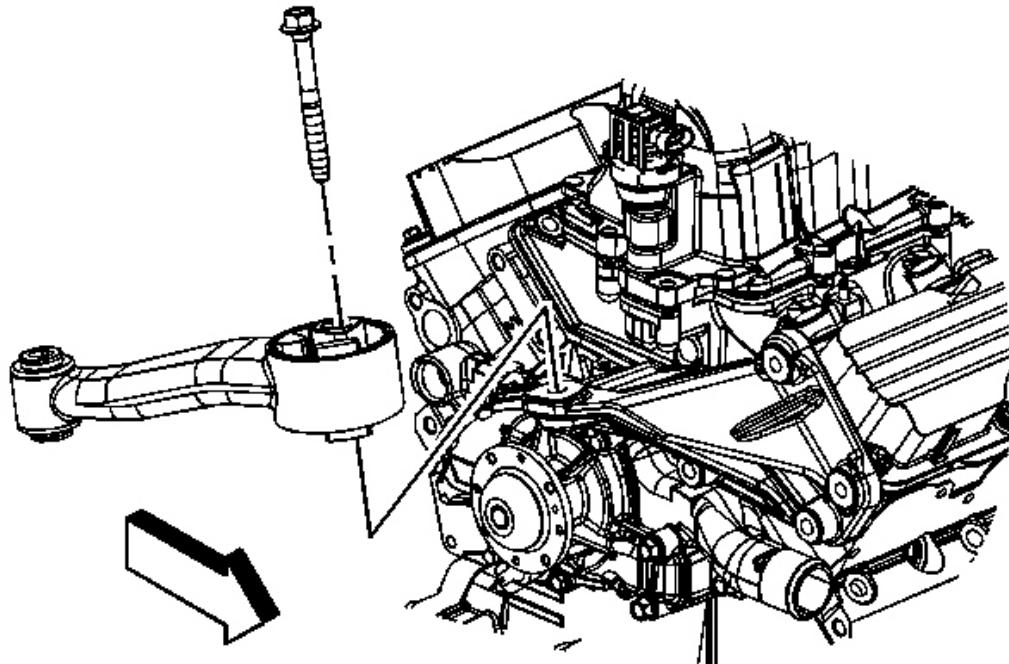


**Fig. 49: View Of Engine Mount Strut Brace Bolt & Nut**  
Courtesy of GENERAL MOTORS CORP.

3. Remove the engine mount strut brace bolt and nut.
4. Remove the engine mount strut brace.

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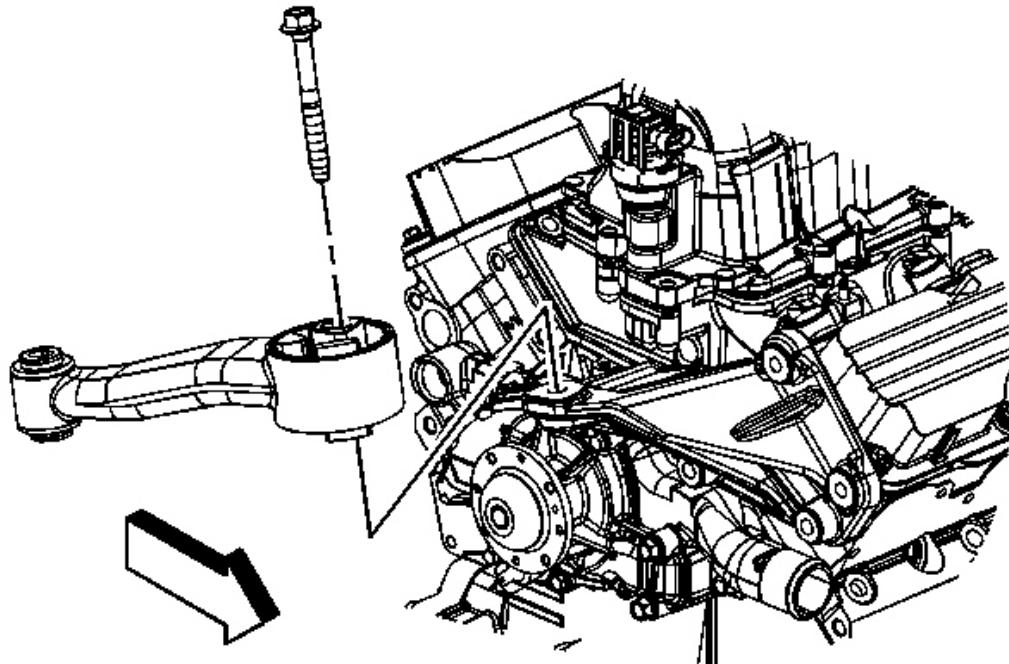
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**Fig. 50: Identifying Engine Mount Strut Bolt**  
Courtesy of GENERAL MOTORS CORP.

5. Remove the engine mount strut bolt.
6. Remove the engine mount strut.

### Installation Procedure



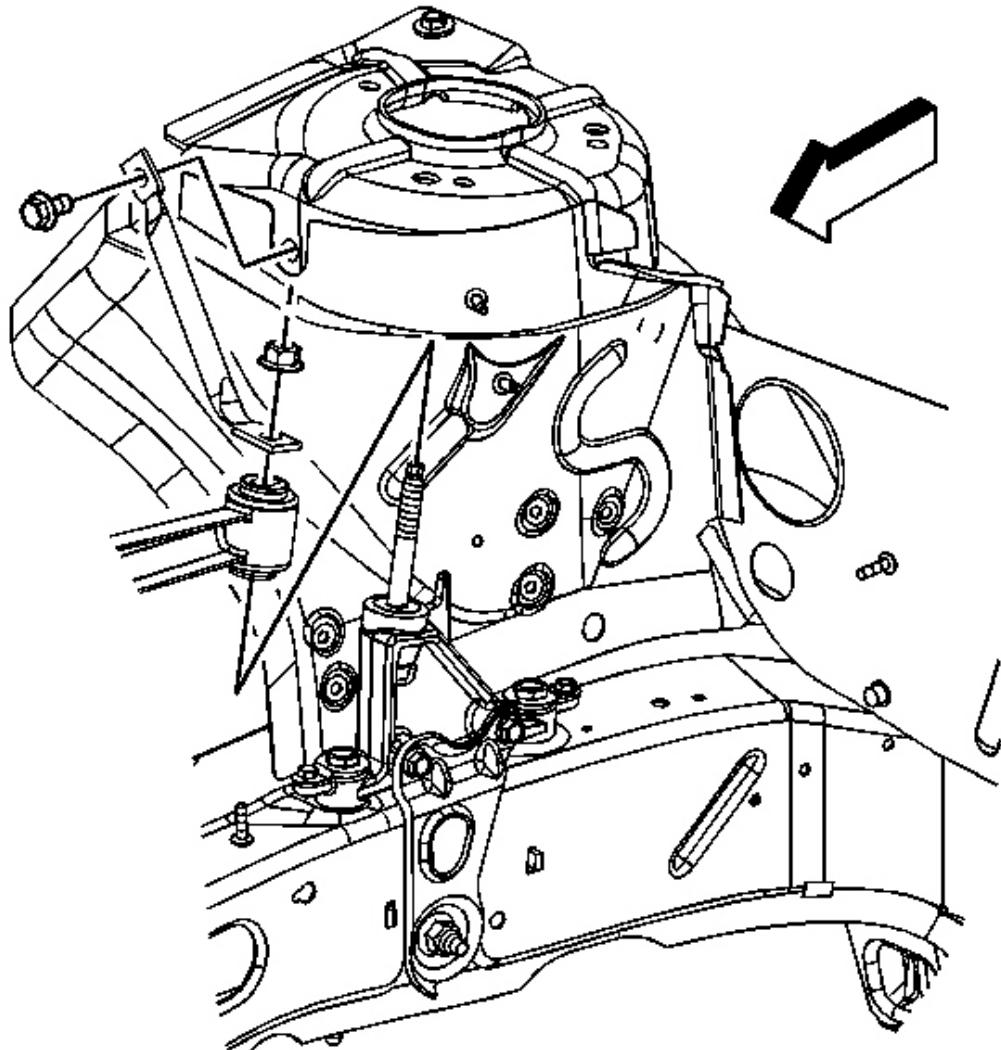
**Fig. 51: Identifying Engine Mount Strut Bolt**  
Courtesy of GENERAL MOTORS CORP.

1. Install the engine mount strut.

**NOTE:** Refer to Fastener Notice .

2. Install the engine mount strut bolt.

**Tighten:** Tighten the bolt to 70 N.m (52 lb ft).



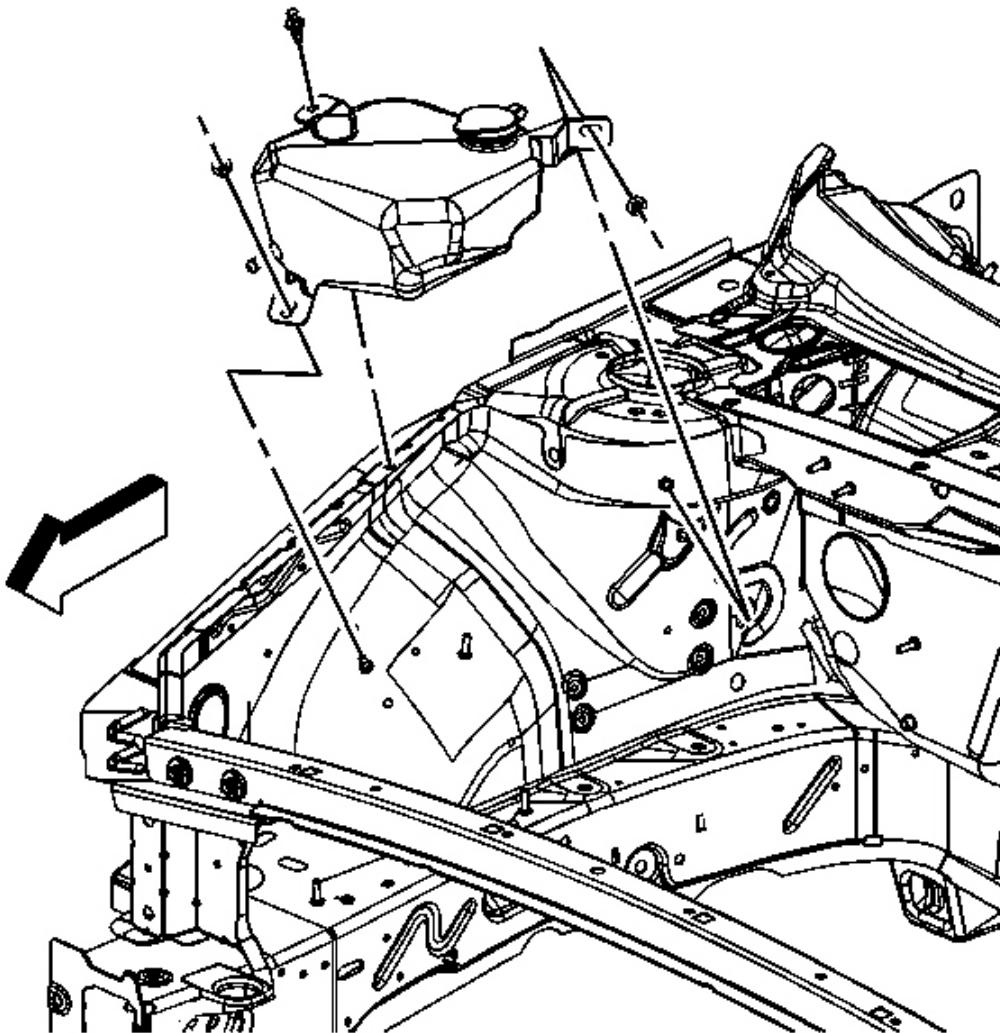
**Fig. 52: View Of Engine Mount Strut Brace Bolt & Nut**  
Courtesy of GENERAL MOTORS CORP.

3. Install the engine mount strut brace.
4. Install the engine mount strut brace bolt and nut.

**Tighten:**

- Tighten the bolt to 50 N.m (37 lb ft).

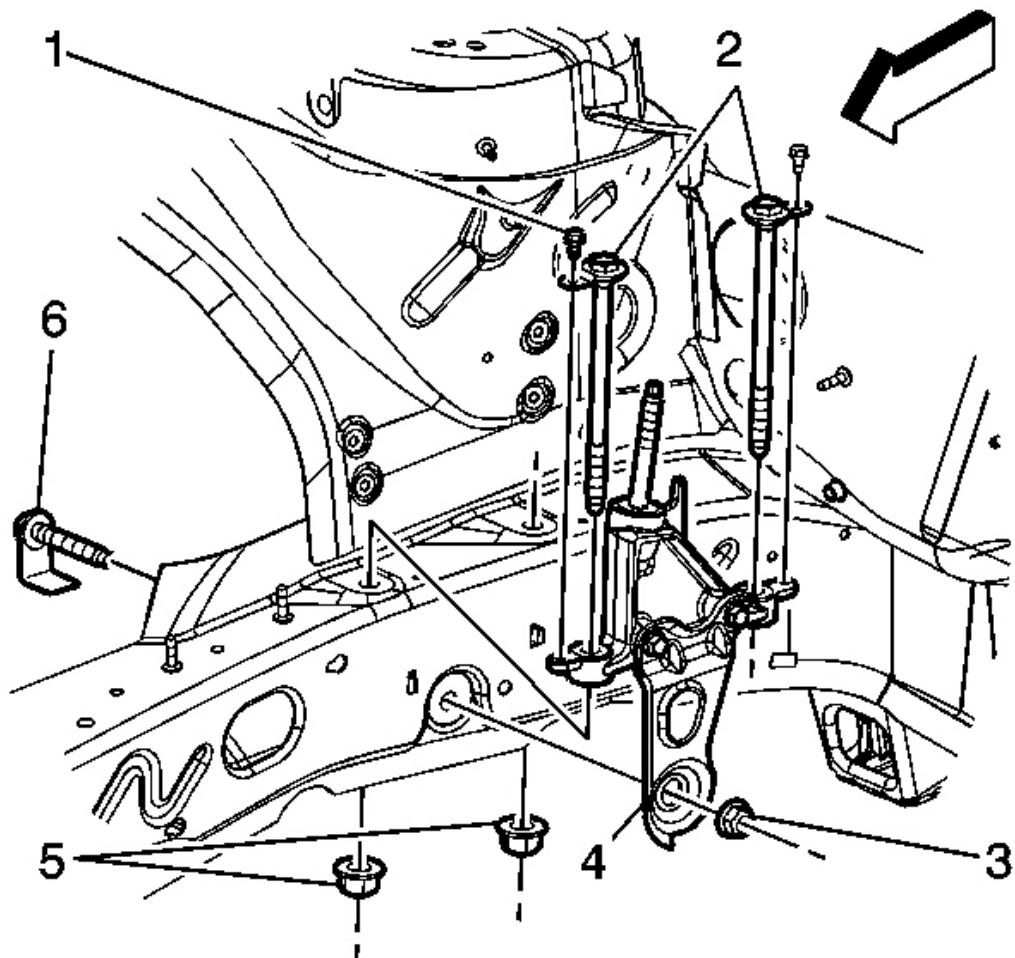
- Tighten the nut to 70 N.m (52 lb ft).



**Fig. 53: Identifying Coolant Reservoir & Nuts**  
Courtesy of GENERAL MOTORS CORP.

5. Position the recovery reservoir to the studs.
6. Install the recovery reservoir nuts and push pin retainer.

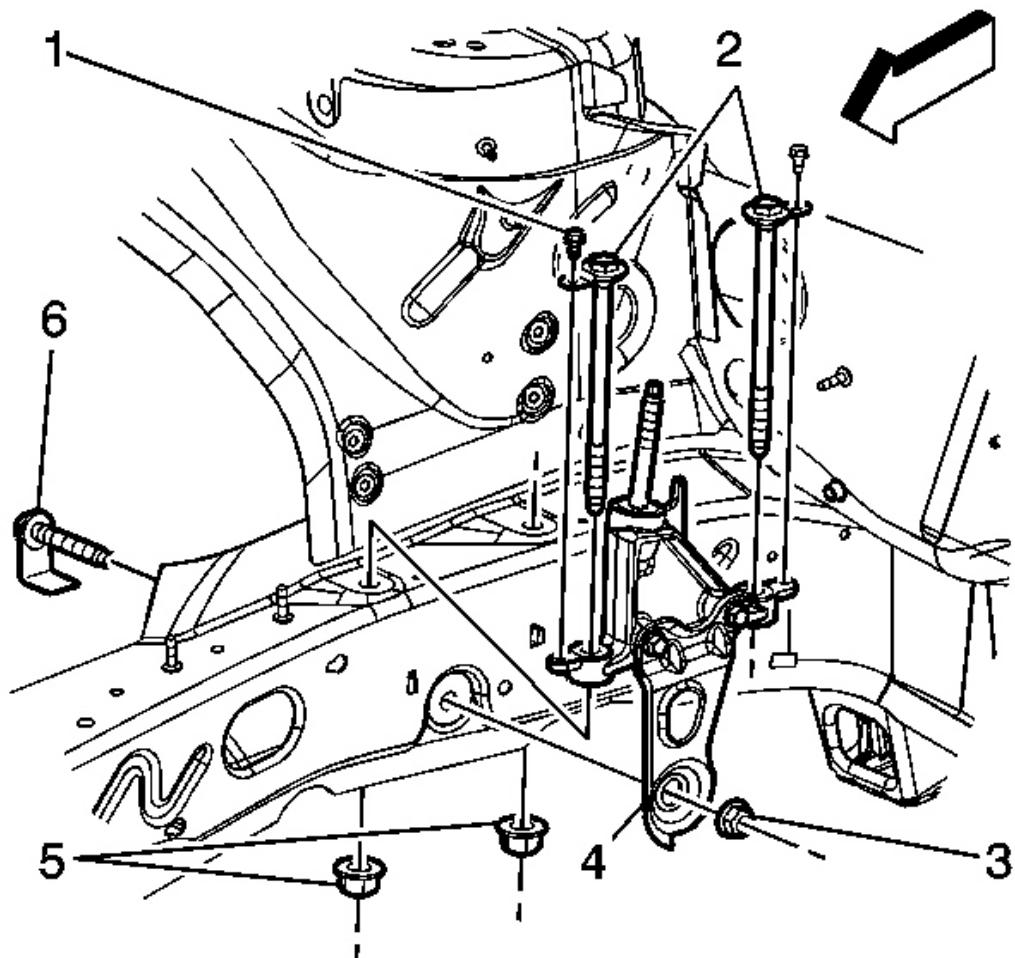
**Tighten:** Tighten the nuts to 6 N.m (53 lb in).

**ENGINE MOUNT STRUT BODY SIDE BRACKET REPLACEMENT****Removal Procedure****Fig. 54: View Of Engine Mount Strut Bracket & Bolts**

Courtesy of GENERAL MOTORS CORP.

1. Remove the engine mount strut. Refer to [Engine Mount Strut Replacement](#).
2. Remove the right front wheel and tire. Refer to [Tire and Wheel Removal and Installation](#).
3. Remove the strut bracket nut (3).

4. Remove the strut bracket bolt (6).
5. Remove the strut bracket nuts (5).
6. Remove the engine mount strut bracket bolts (1).
7. Remove the strut bracket bolts (2).
8. Remove the strut bracket (4).

**Installation Procedure****Fig. 55: View Of Engine Mount Strut Bracket & Bolts**

Courtesy of GENERAL MOTORS CORP.

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1. Position the engine mount strut bracket (4) to the front compartment rail.
2. Install the strut bracket bolts (2).
3. Install the strut bracket bolt (6).

**NOTE:** Refer to Fastener Notice .

4. Install the strut bracket nut (3).

**Tighten:** Tighten the nut to 70 N.m (52 lb ft).

5. Install the strut bracket nuts (5).

**Tighten:** Tighten the nuts to 70 N.m (52 lb ft).

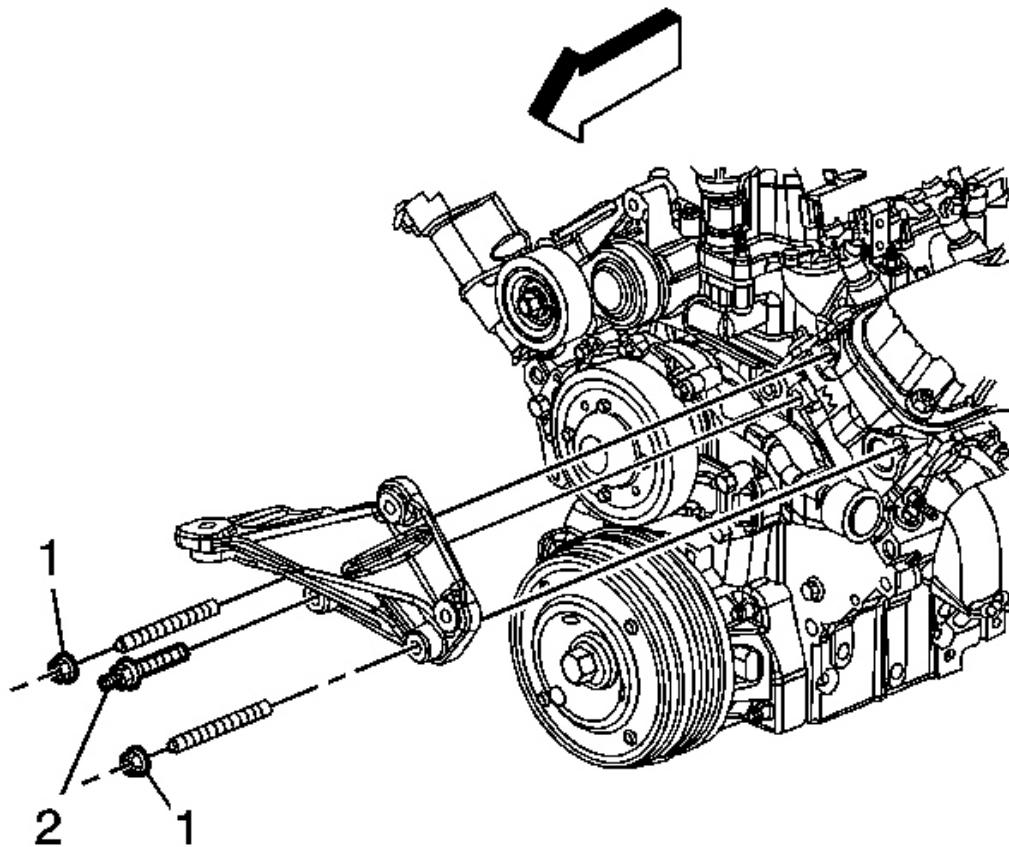
6. Install the strut bracket bolts (1).

**Tighten:** Tighten the bolts to 6 N.m (53 lb in).

7. Install the right front wheel and tire. Refer to Tire and Wheel Removal and Installation .
8. Install the engine mount strut. Refer to Engine Mount Strut Replacement.

## ENGINE MOUNT STRUT ENGINE SIDE BRACKET REPLACEMENT

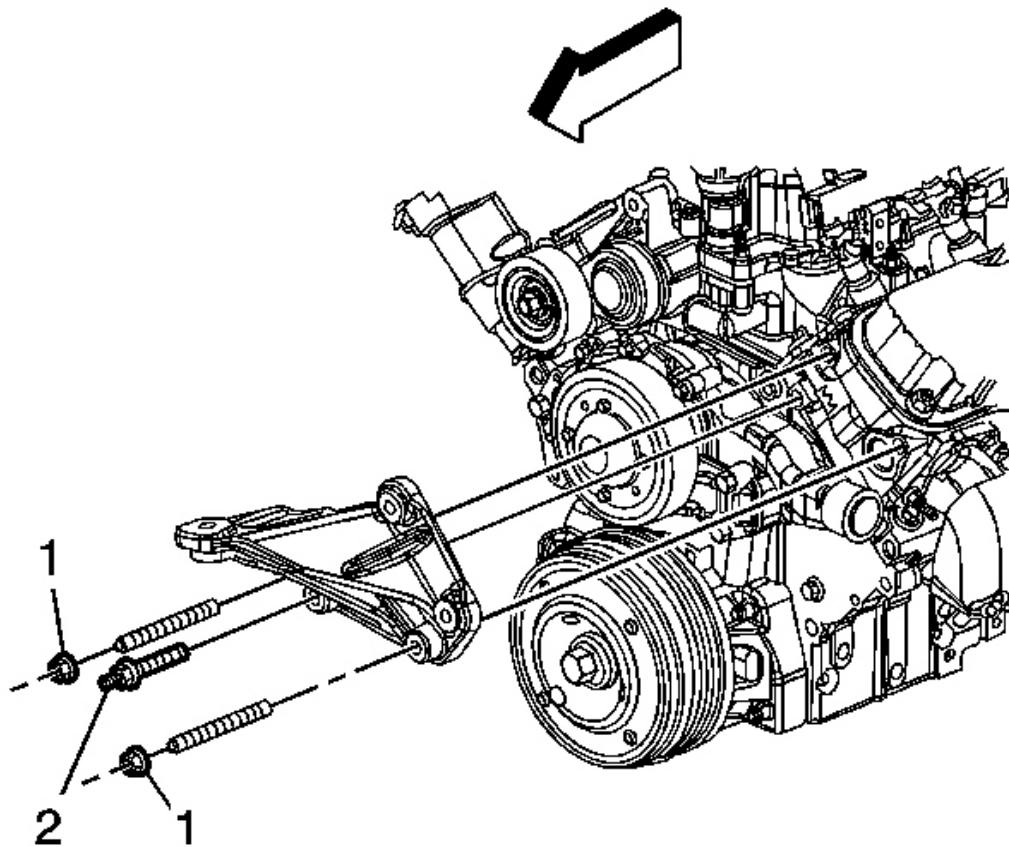
### Removal Procedure



**Fig. 56: Identifying Engine Mount Strut Engine Side Bracket & Bolts**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the ignition control module. Refer to [Ignition Control Module Replacement](#) .
2. Remove the engine mount strut. Refer to [Engine Mount Strut Replacement](#).
3. Remove the engine mount strut bracket nuts (1).
4. Remove the engine mount strut bracket stud (3).
5. Remove the engine mount strut bracket from the studs.

#### Installation Procedure



**Fig. 57: Identifying Engine Mount Strut Engine Side Bracket & Bolts**  
Courtesy of GENERAL MOTORS CORP.

1. Install the engine mount strut bracket to the studs.
2. Install the engine mount strut bracket stud (3).

**NOTE: Refer to Fastener Notice .**

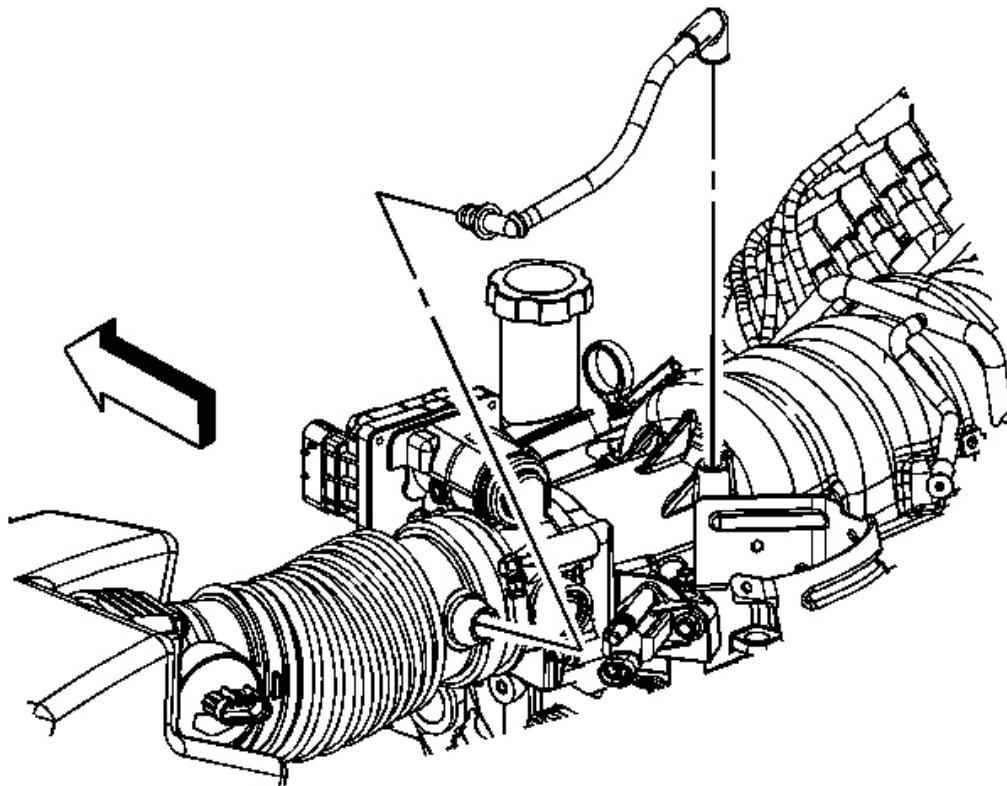
3. Install the engine mount strut bracket nuts (1).

**Tighten:** Tighten the stud/nuts to 50 N.m (37 lb ft).

4. Install the engine mount strut. Refer to Engine Mount Strut Replacement.
5. Install the ignition control module. Refer to Ignition Control Module Replacement.

## POSITIVE CRANKCASE VENTILATION TUBE REPLACEMENT

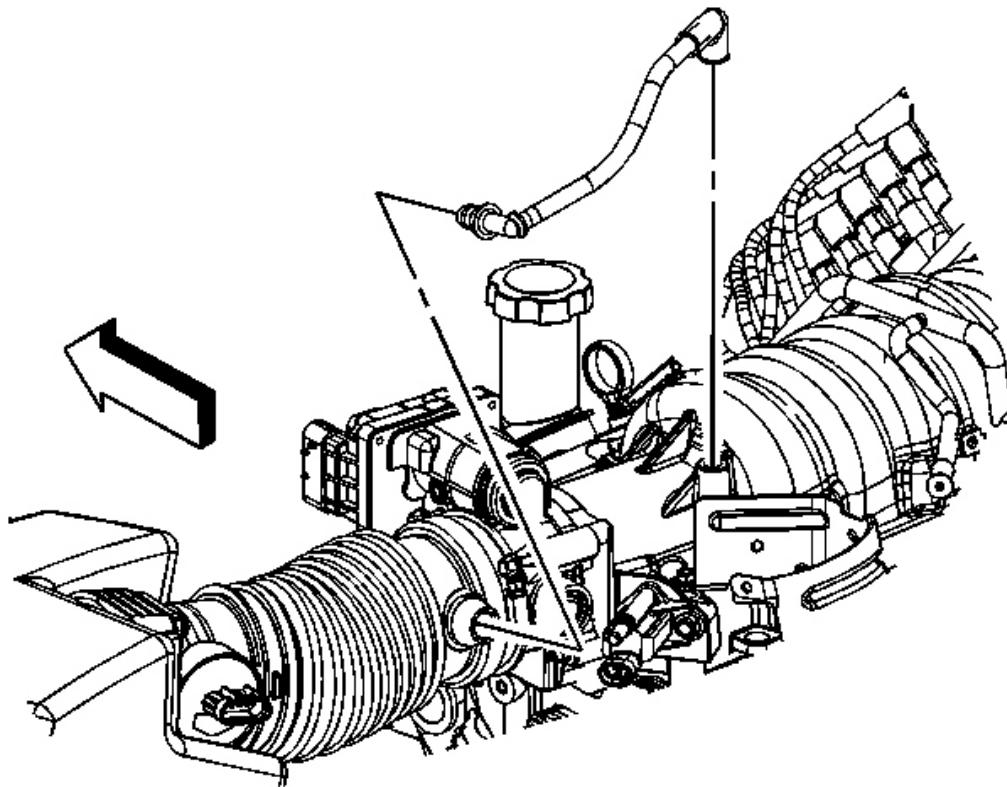
### Removal Procedure



**Fig. 58: Identifying Positive Crankcase Ventilation (PCV) Tube**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the intake manifold cover. Refer to [Intake Manifold Cover Replacement](#).
2. Remove the positive crankcase ventilation (PCV) tube from the intake manifold.
3. Remove the PCV tube from the air cleaner outlet duct.

### Installation Procedure



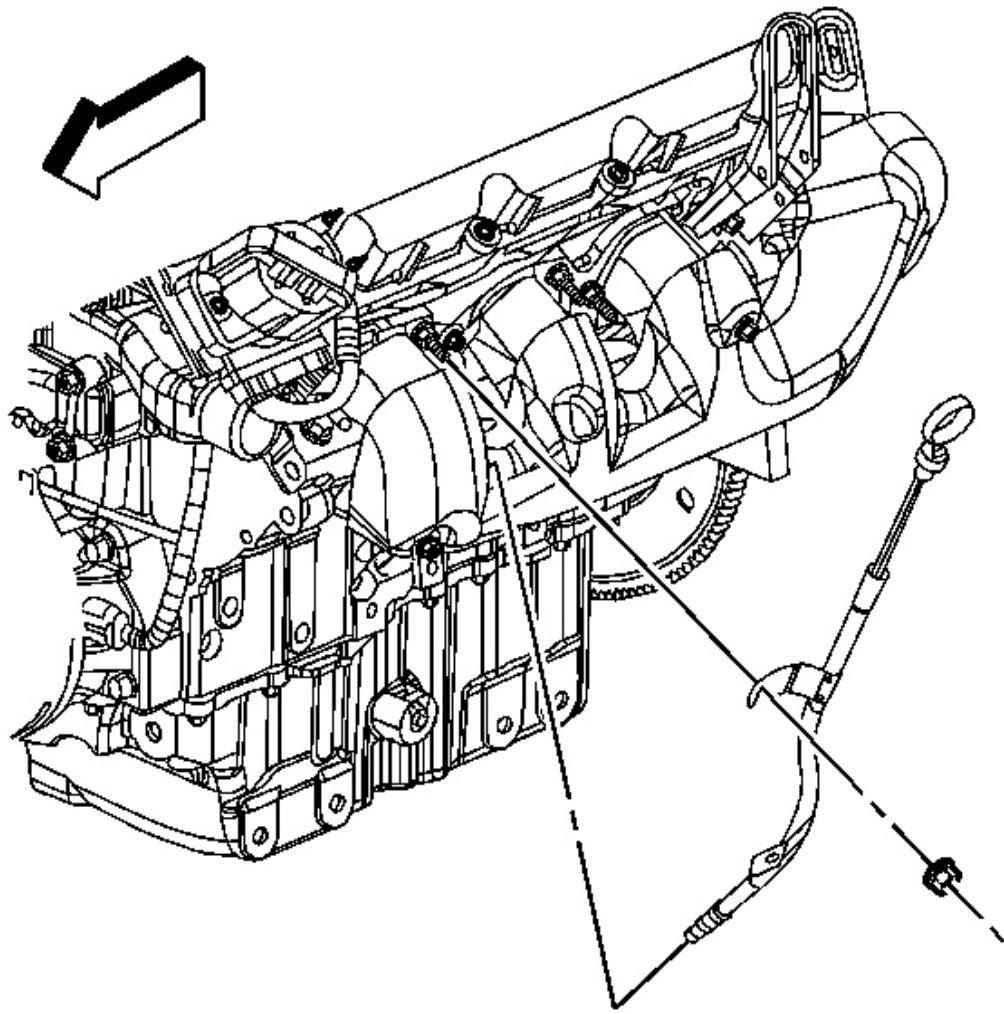
**Fig. 59: Identifying Positive Crankcase Ventilation (PCV) Tube**

Courtesy of GENERAL MOTORS CORP.

1. Install the PCV tube to the intake manifold.
2. Install the PCV tube to the air cleaner outlet duct.
3. Install the intake manifold cover. Refer to [Intake Manifold Cover Replacement](#).

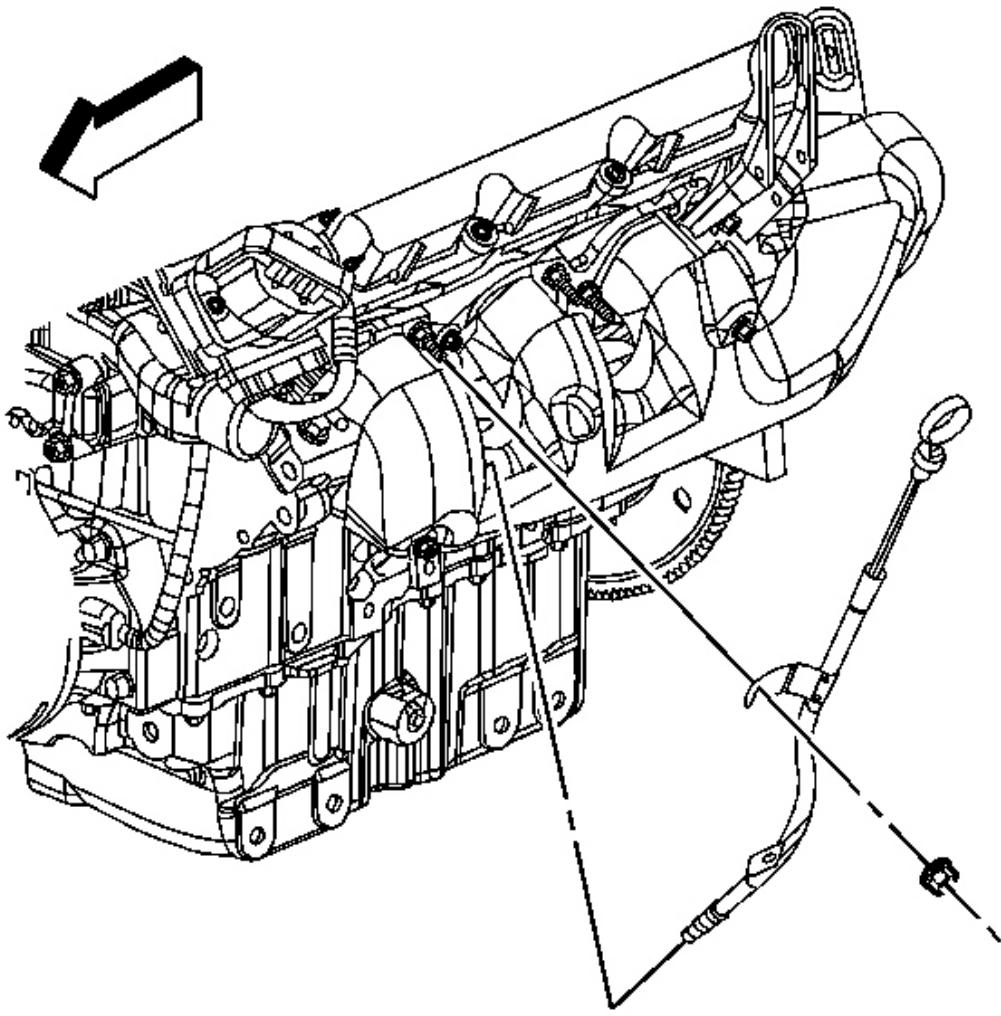
#### **OIL LEVEL INDICATOR AND TUBE REPLACEMENT**

##### **Removal Procedure**



**Fig. 60: Identifying Oil Level Indicator & Tube**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the intake manifold cover. Refer to [Intake Manifold Cover Replacement](#).
2. Remove the oil level indicator.
3. Loosen the oil level indicator tube nut.
4. Pull upward and remove the oil level indicator tube.



**Fig. 61: Identifying Oil Level Indicator & Tube**  
Courtesy of GENERAL MOTORS CORP.

1. Ensure that the lower O-ring seal is in place and lubricate the seal with clean engine oil.
2. Position the indicator tube bracket behind the tube nut and insert the indicator tube into the engine block hole.
3. Push down on the indicator tube ensuring that the tube is fully seated.

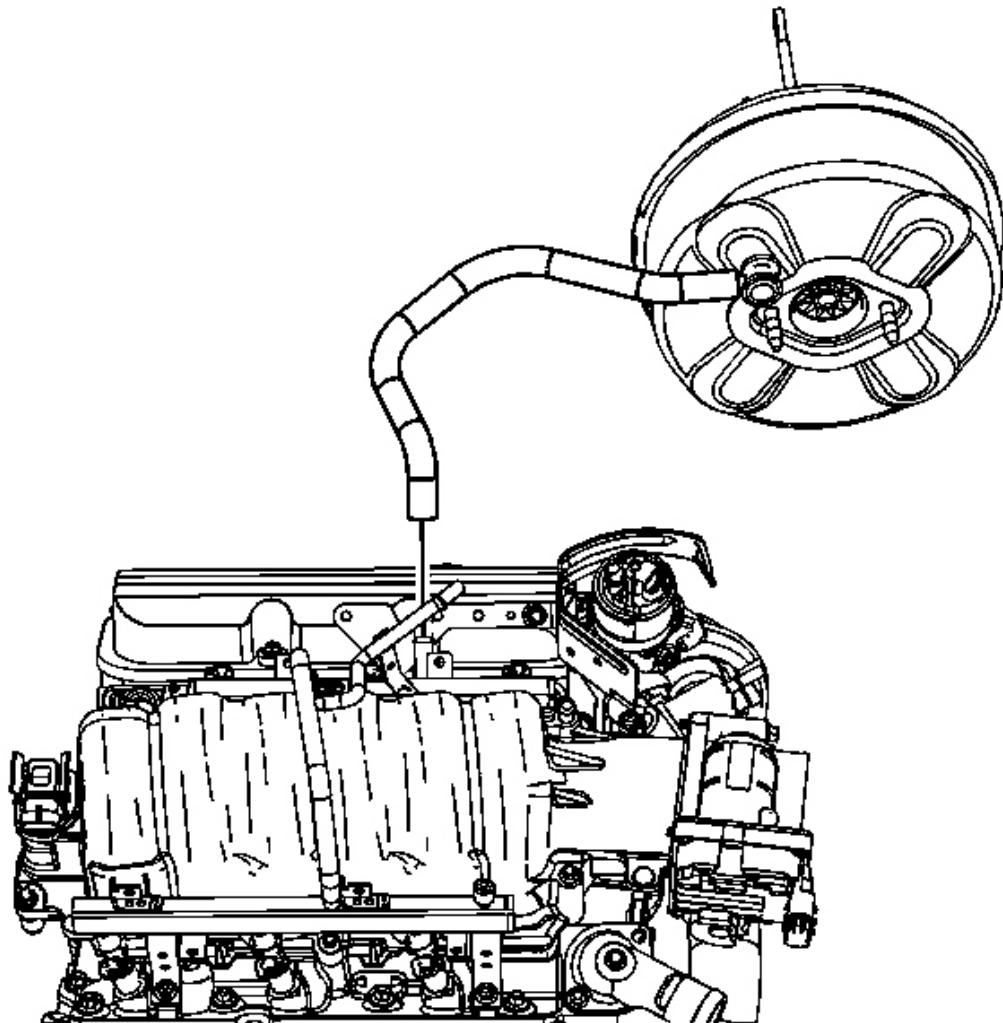
**NOTE: Refer to Fastener Notice .**

4. Tighten the oil level indicator tube nut.

**Tighten:** Tighten the nut to 19 N.m (14 lb ft).

## UPPER INTAKE MANIFOLD REPLACEMENT

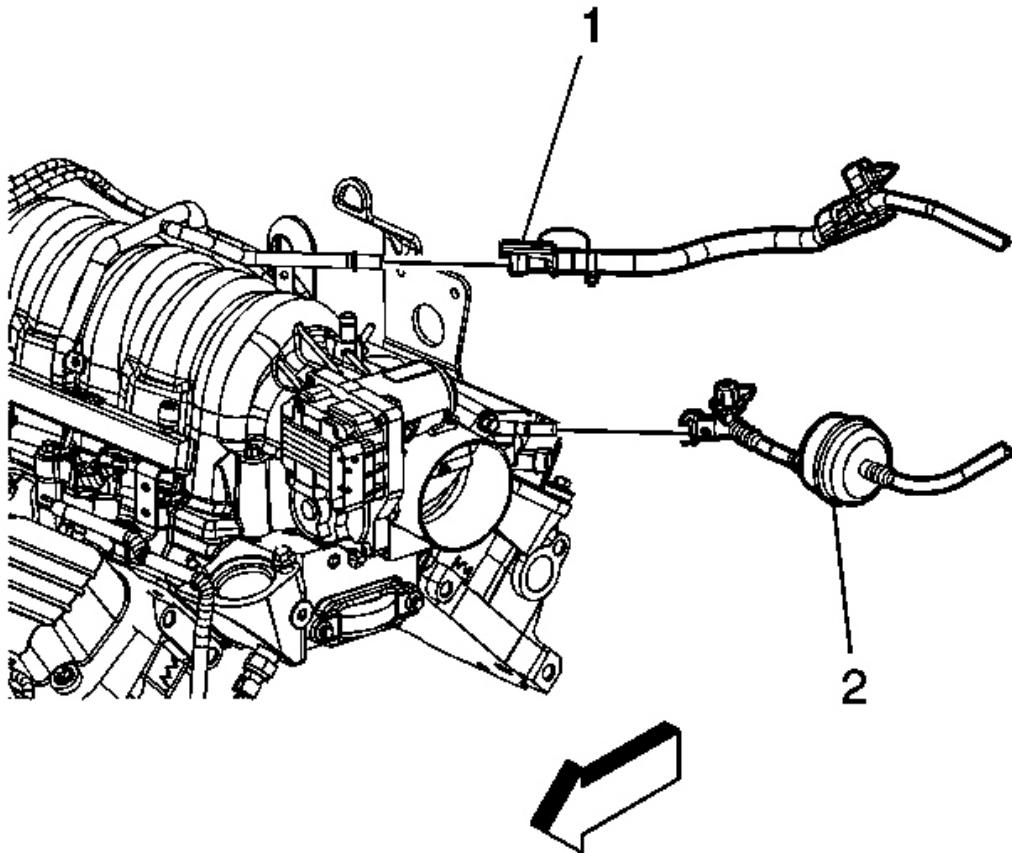
### Removal Procedure



**Fig. 62: View Of Brake Booster Vacuum Hose**

Courtesy of GENERAL MOTORS CORP.

1. Remove the air cleaner outlet duct.
2. Remove the fuel rail assembly. Refer to [Fuel Injection Fuel Rail Assembly Replacement](#).
3. Remove the brake booster vacuum hose from the upper intake manifold fitting.

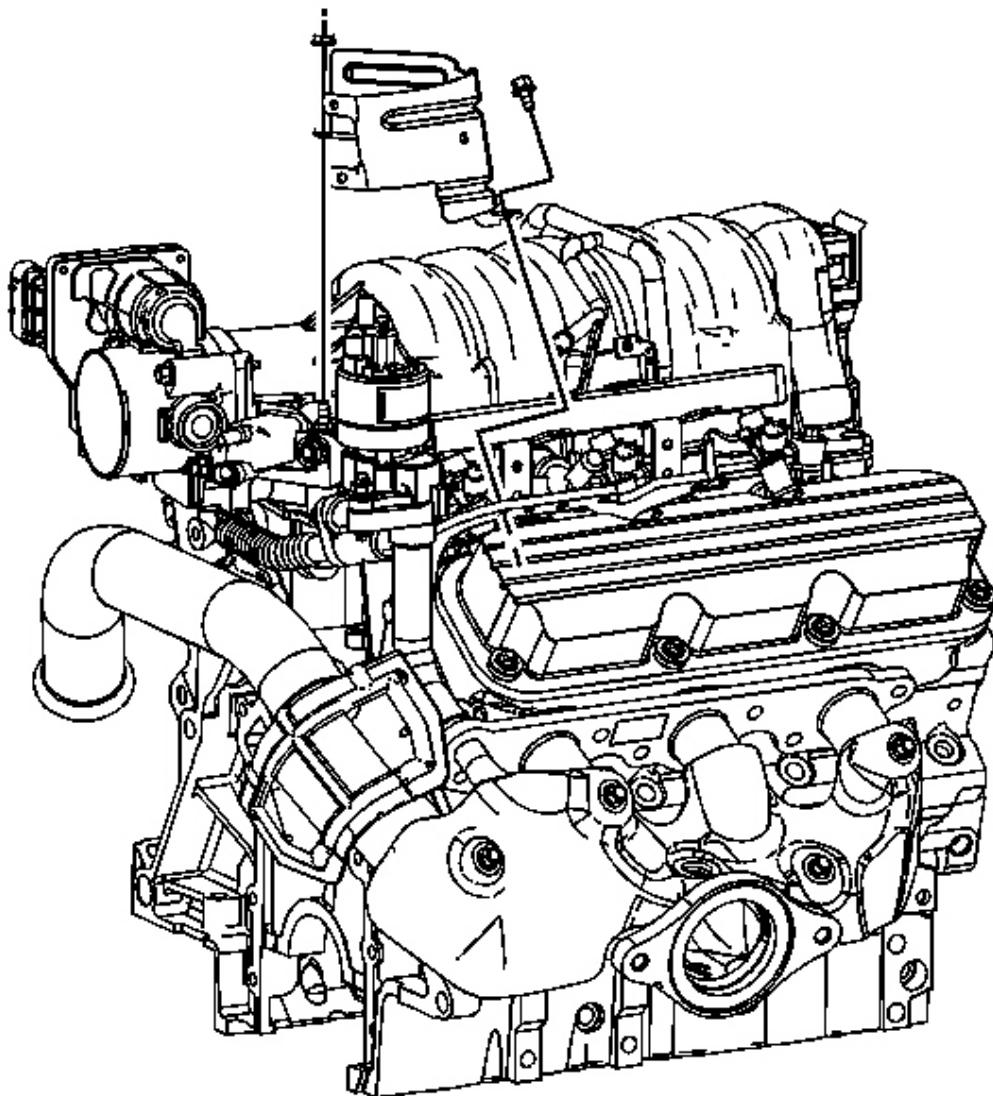


**Fig. 63: Locating Evaporative Emission (EVAP) Pipe Quick Connect Fitting**  
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the evaporative emission (EVAP) pipe quick connect fitting (2) from the purge solenoid. Refer to [Plastic Collar Quick Connect Fitting Service](#).

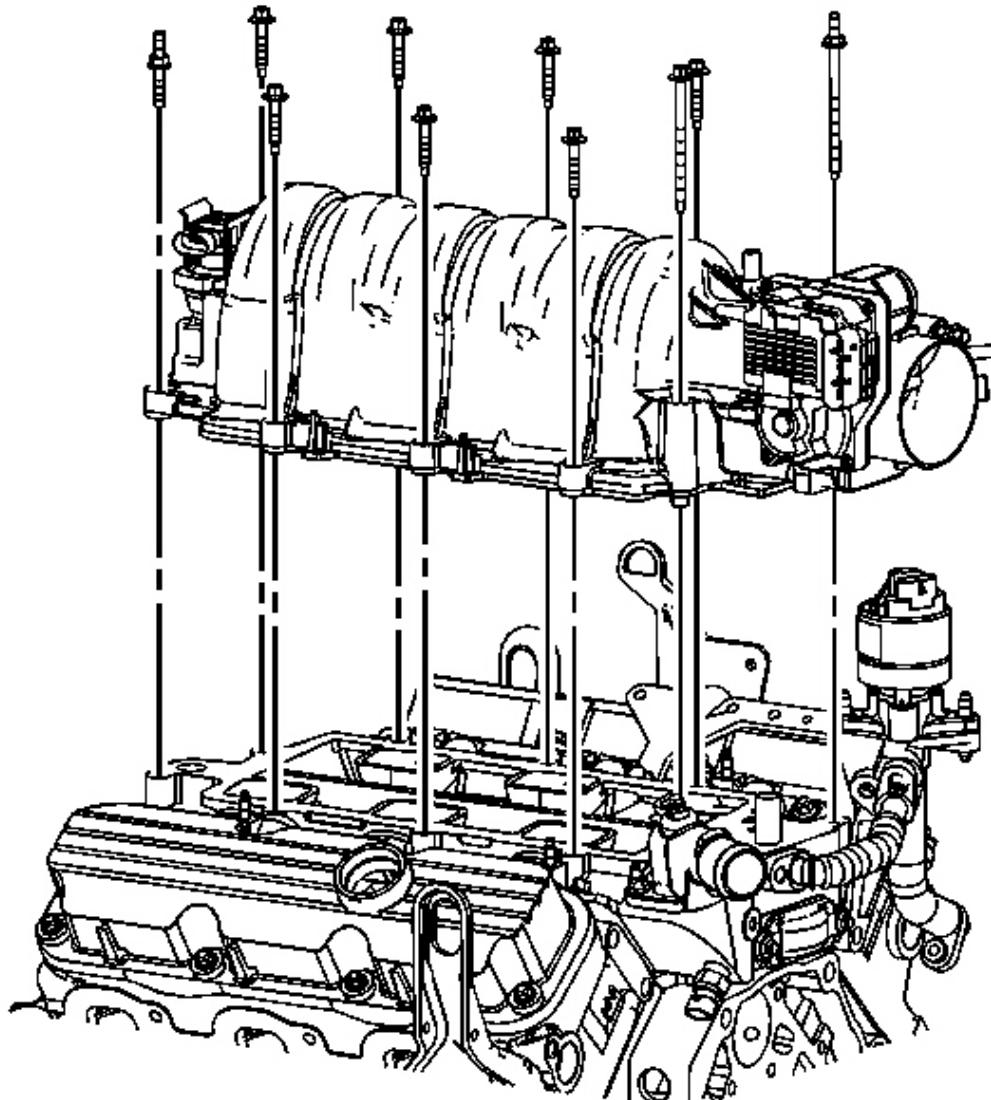
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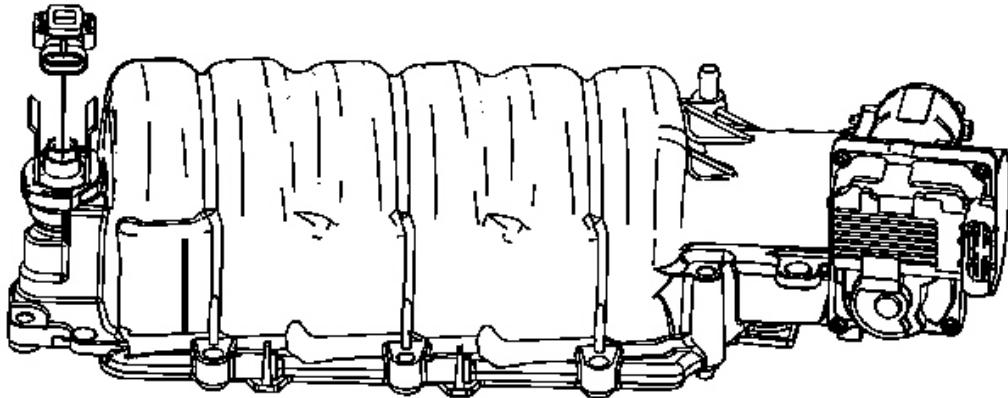
**Fig. 64: View Of Engine Wiring Harness & Heat Shield**  
Courtesy of GENERAL MOTORS CORP.

5. Remove the engine wiring harness heat shield nut and bolt.
6. Remove the engine wiring harness heat shield.



**Fig. 65: Identifying Upper Intake Manifold Bolts & Studs**  
Courtesy of GENERAL MOTORS CORP.

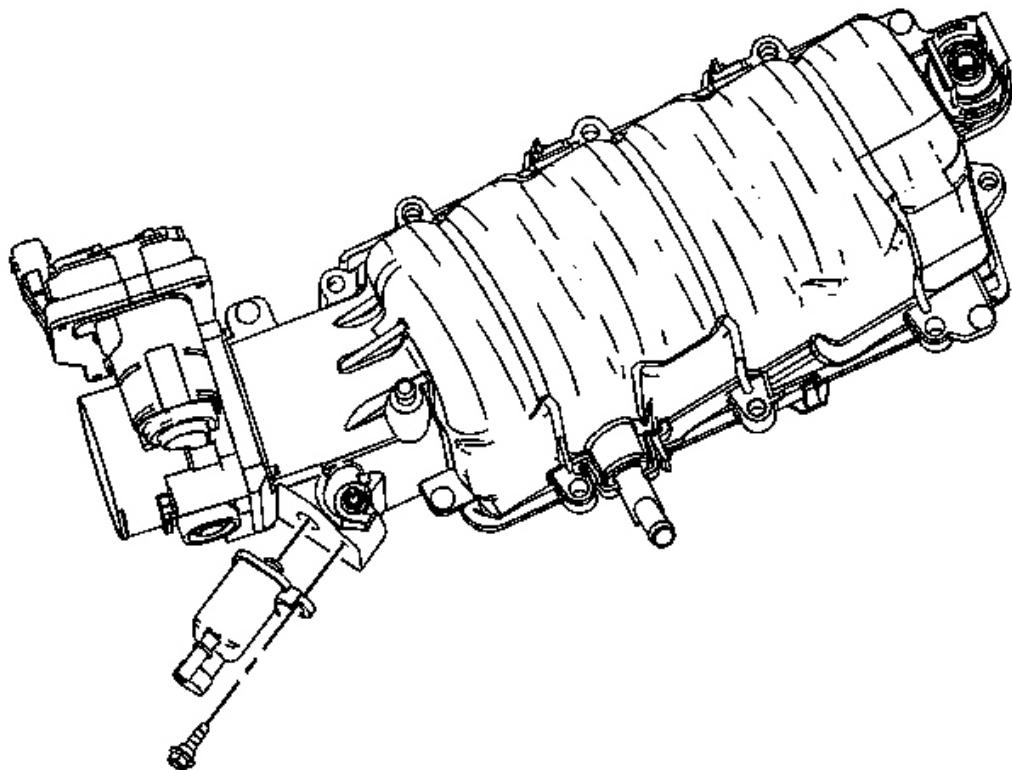
7. Remove the upper intake manifold bolts and studs.
8. Remove the upper intake manifold.



**Fig. 66: View Of Upper Intake Manifold & MAP Sensor**

Courtesy of GENERAL MOTORS CORP.

9. If replacing the intake manifold perform the following steps, otherwise proceed to step 10 in the installation procedure.
10. Disengage the retainers and remove the manifold absolute pressure (MAP) sensor.

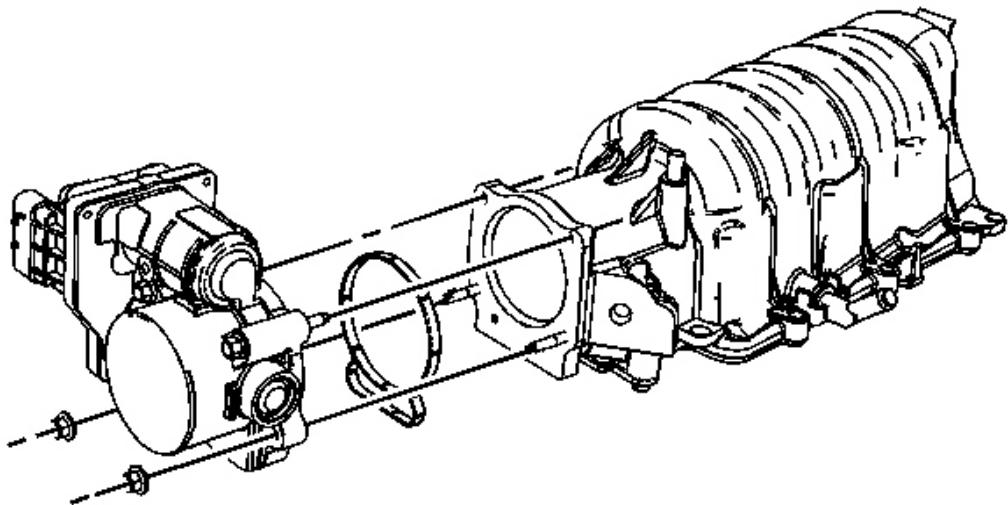


**Fig. 67: Locating EVAP Purge Solenoid & Bolt**  
Courtesy of GENERAL MOTORS CORP.

11. Remove the EVAP purge solenoid bolt and solenoid.

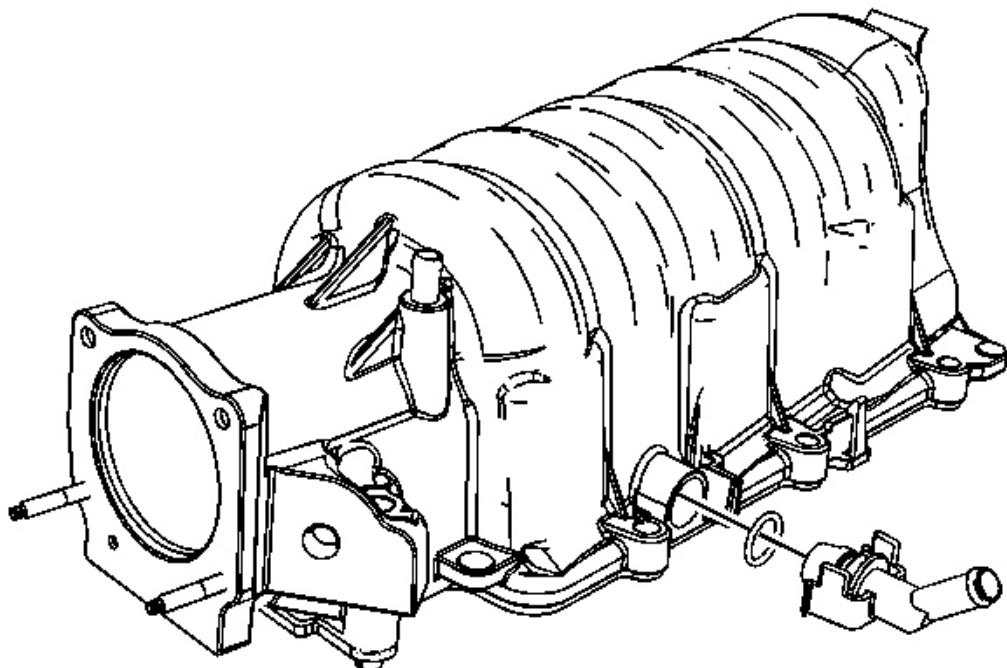
## 2006 Buick Lucerne CXS

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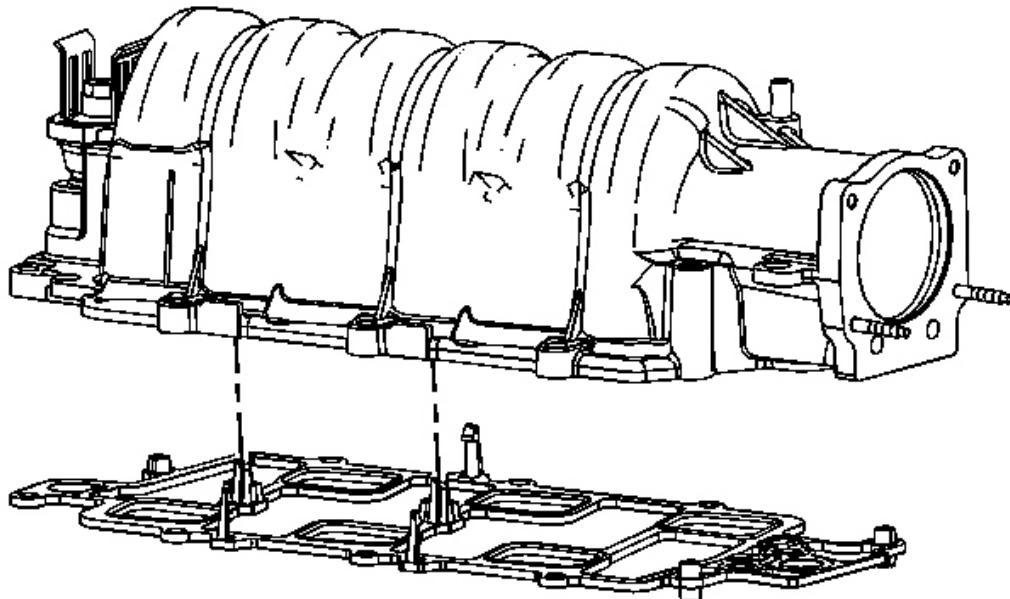
**Fig. 68: Identifying Throttle Body & Bolts**  
Courtesy of GENERAL MOTORS CORP.

12. Loosen the throttle body upper bolts.
13. Remove the throttle body lower nuts.
14. Remove the throttle body.



**Fig. 69: Locating Vacuum Fitting & O-Ring Seal**  
Courtesy of GENERAL MOTORS CORP.

15. Squeeze the sides of the vacuum fitting in order to disengage the retainers and remove the vacuum fitting.
16. Remove and discard the O-ring seal.

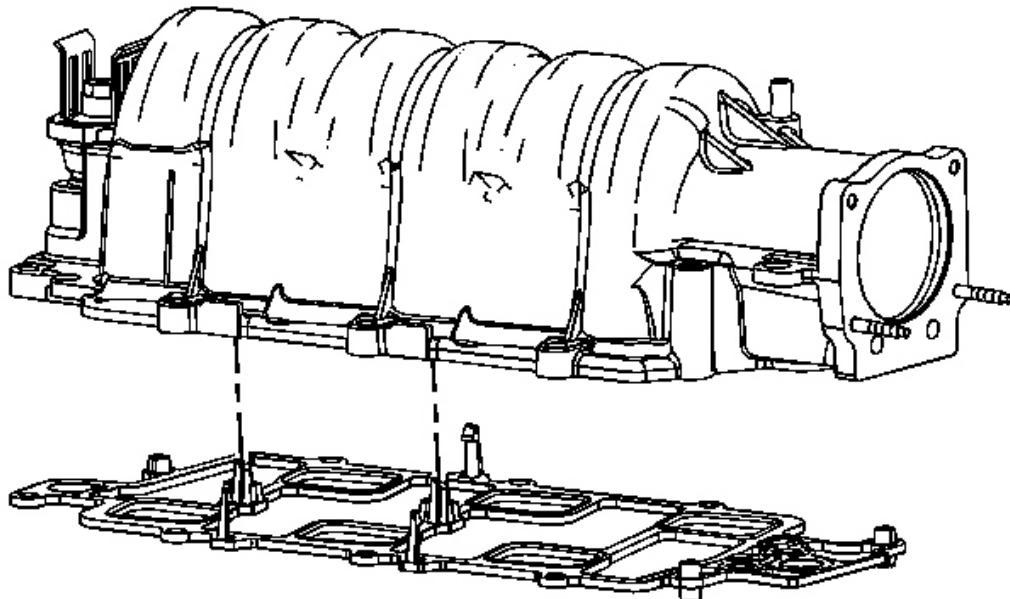


**Fig. 70: Intake Manifold, Gasket & Carrier**

Courtesy of GENERAL MOTORS CORP.

17. Remove the intake manifold gasket carrier from the upper intake manifold.

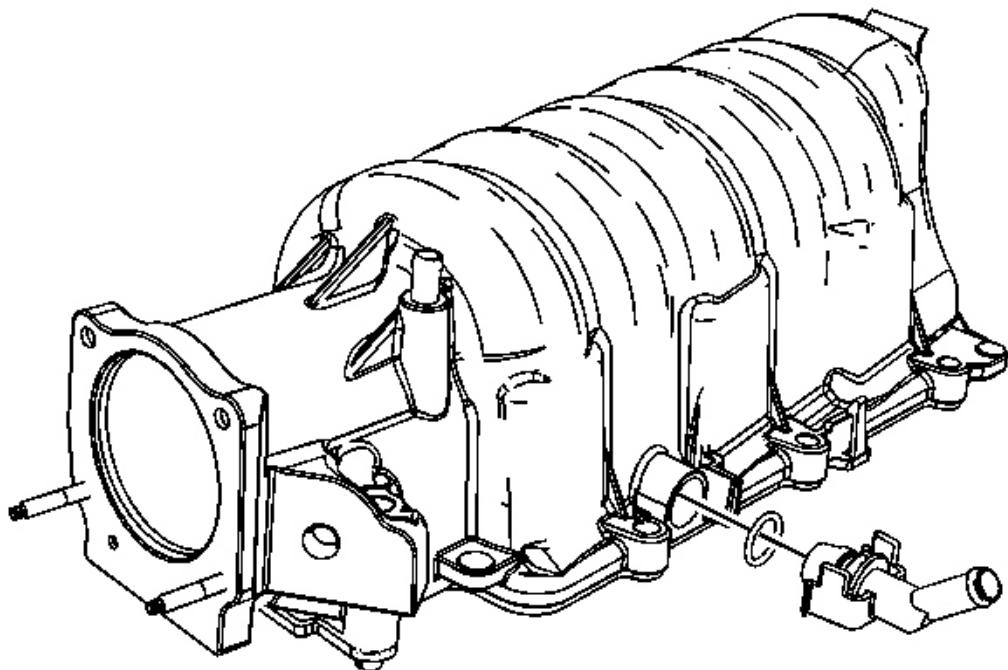
**Installation Procedure**



**Fig. 71: Intake Manifold, Gasket & Carrier**

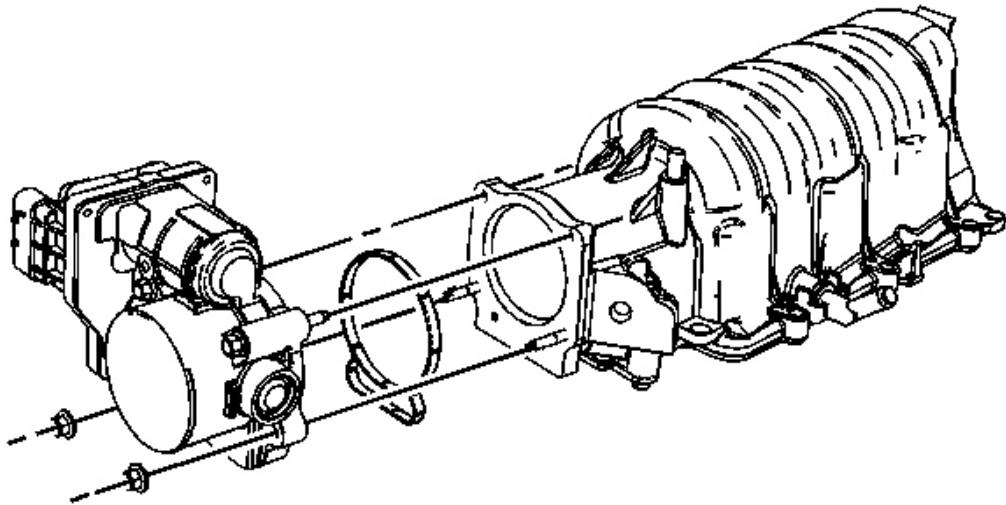
Courtesy of GENERAL MOTORS CORP.

1. If replacing the intake manifold perform the following steps, otherwise proceed to 10.
2. Install a the intake manifold gasket carrier to the upper intake manifold.



**Fig. 72: Identifying Vacuum Fitting & O-Ring Seal**  
Courtesy of GENERAL MOTORS CORP.

3. Install a NEW vacuum fitting O-ring seal.
4. Squeeze the sides of the vacuum fitting in order to install the vacuum fitting.



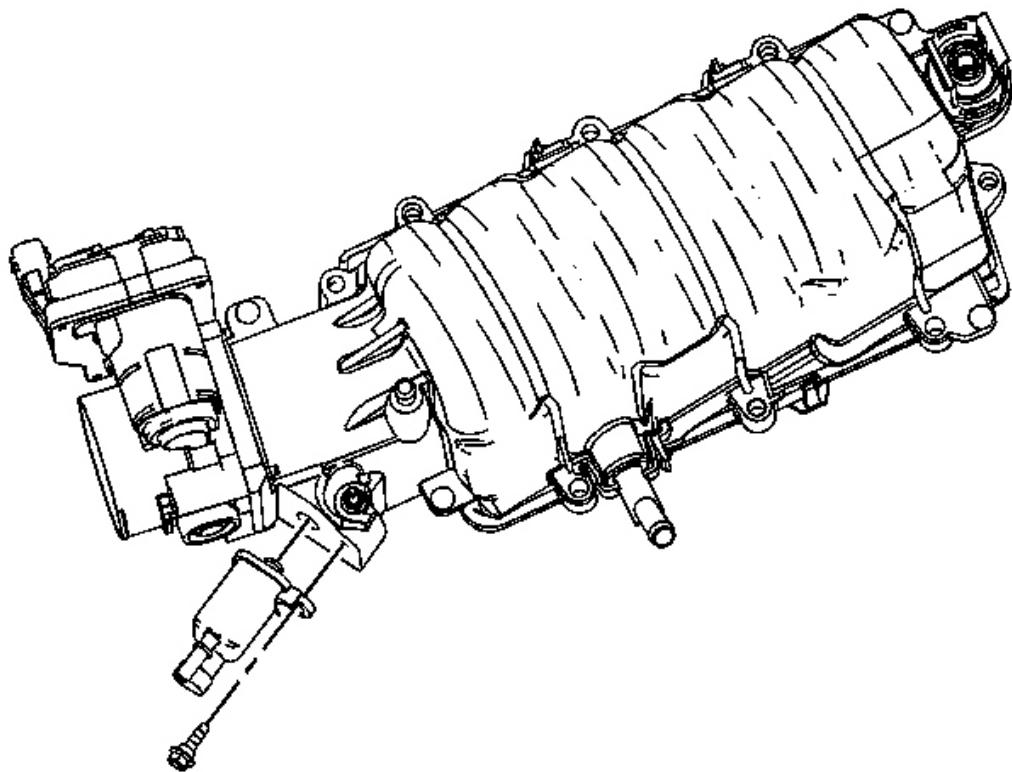
**Fig. 73: Identifying Throttle Body & Bolts**  
Courtesy of GENERAL MOTORS CORP.

5. Install the throttle body.
6. Tighten the throttle body upper bolts.

**NOTE:** Refer to Fastener Notice .

7. Install the throttle body lower nuts.

**Tighten:** Tighten the bolts/nuts to 10 N.m (89 lb in).



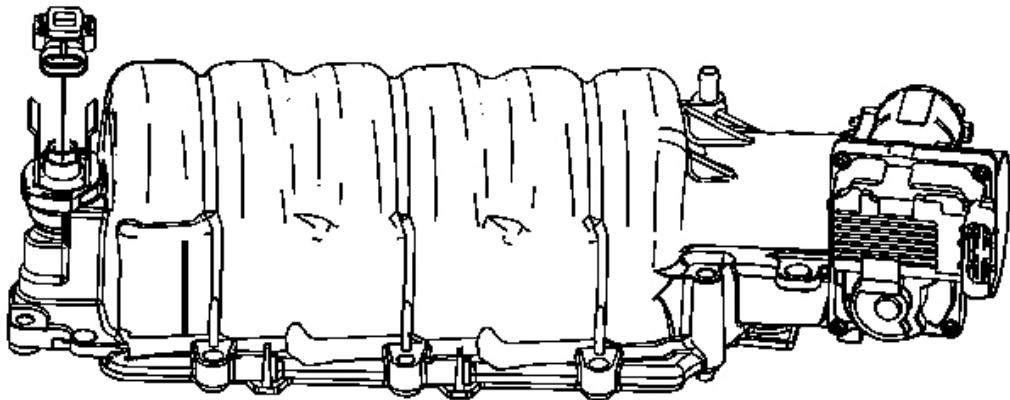
**Fig. 74: Locating EVAP Purge Solenoid & Bolt**  
Courtesy of GENERAL MOTORS CORP.

8. Install the EVAP purge solenoid and bolt.

**Tighten:** Tighten the bolt to 10 N.m (89 lb in).

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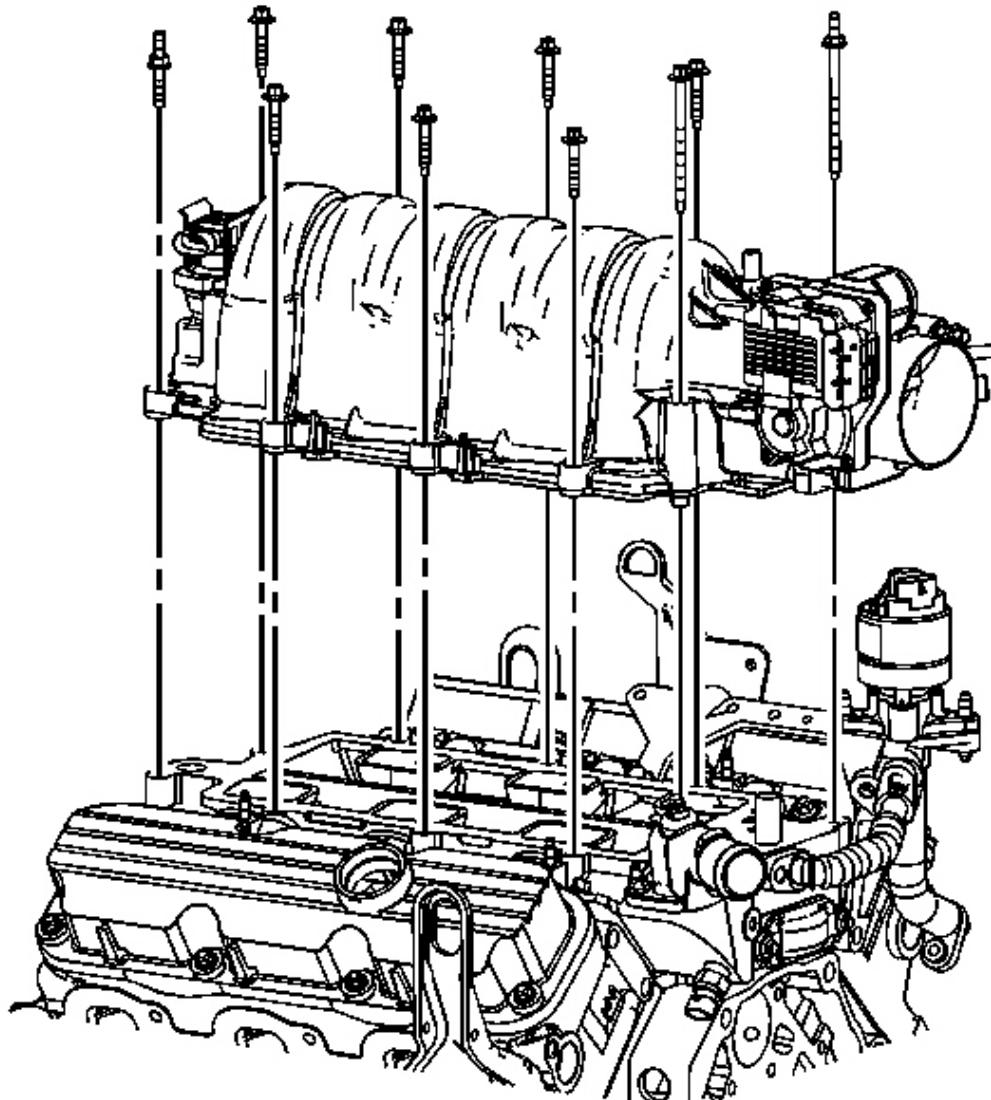
**Fig. 75: View Of Upper Intake Manifold & MAP Sensor**

**Courtesy of GENERAL MOTORS CORP.**

9. Install the MAP sensor.

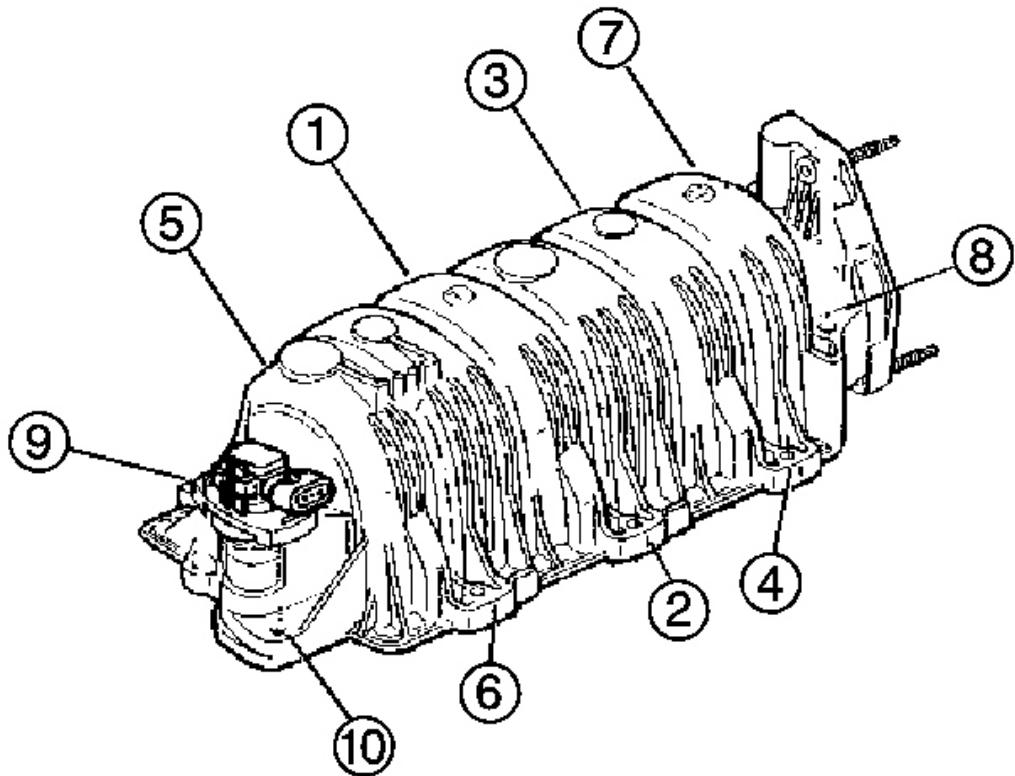
## 2006 Buick Lucerne CXS

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**Fig. 76: Locating Upper Intake Manifold Bolts & Studs**  
Courtesy of GENERAL MOTORS CORP.

10. Install the upper intake manifold.
11. Install the upper intake manifold bolts and studs.



**Fig. 77: Installing Upper Intake Manifold Bolts**

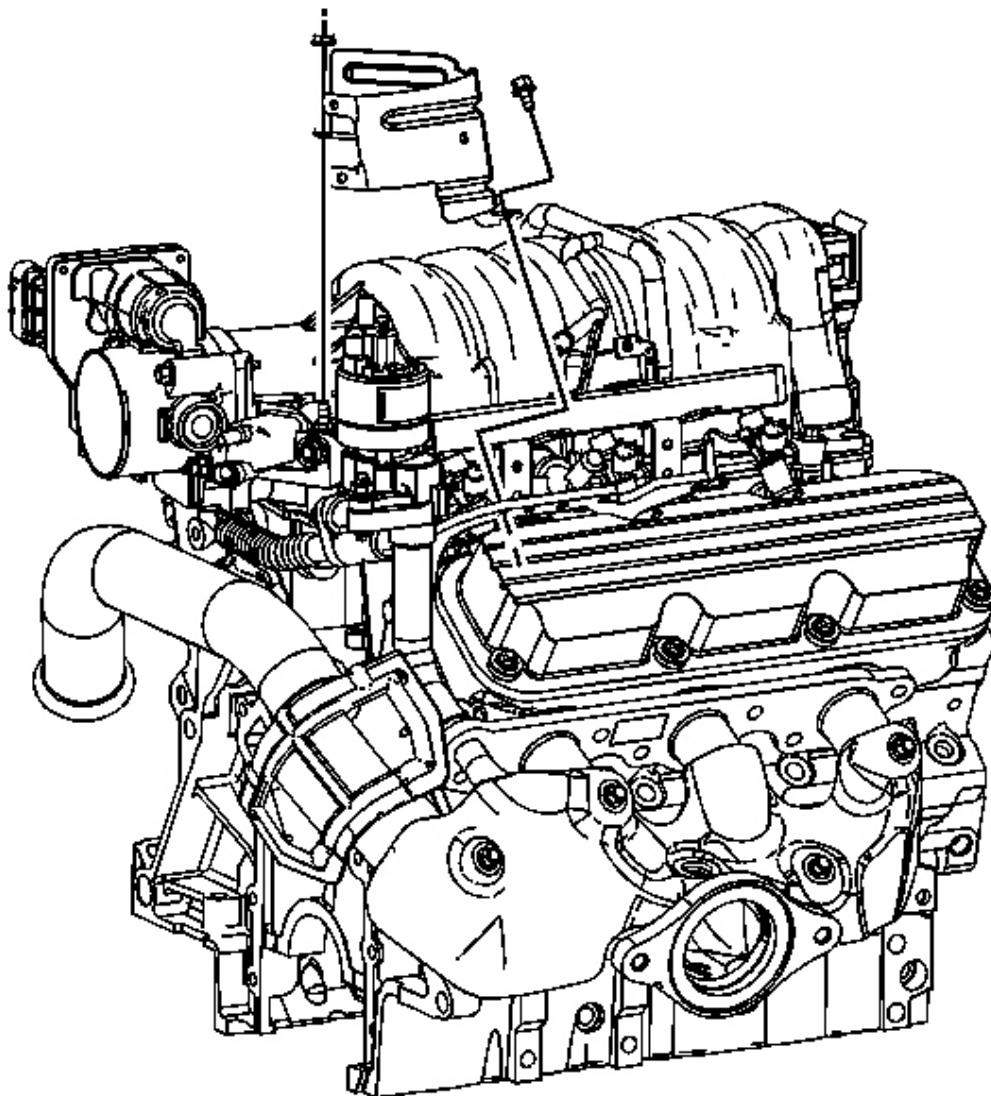
Courtesy of GENERAL MOTORS CORP.

12. Tighten the upper intake manifold bolts and studs in the sequence shown.

**Tighten:** Tighten the bolts/studs to 10 N.m (89 lb in).

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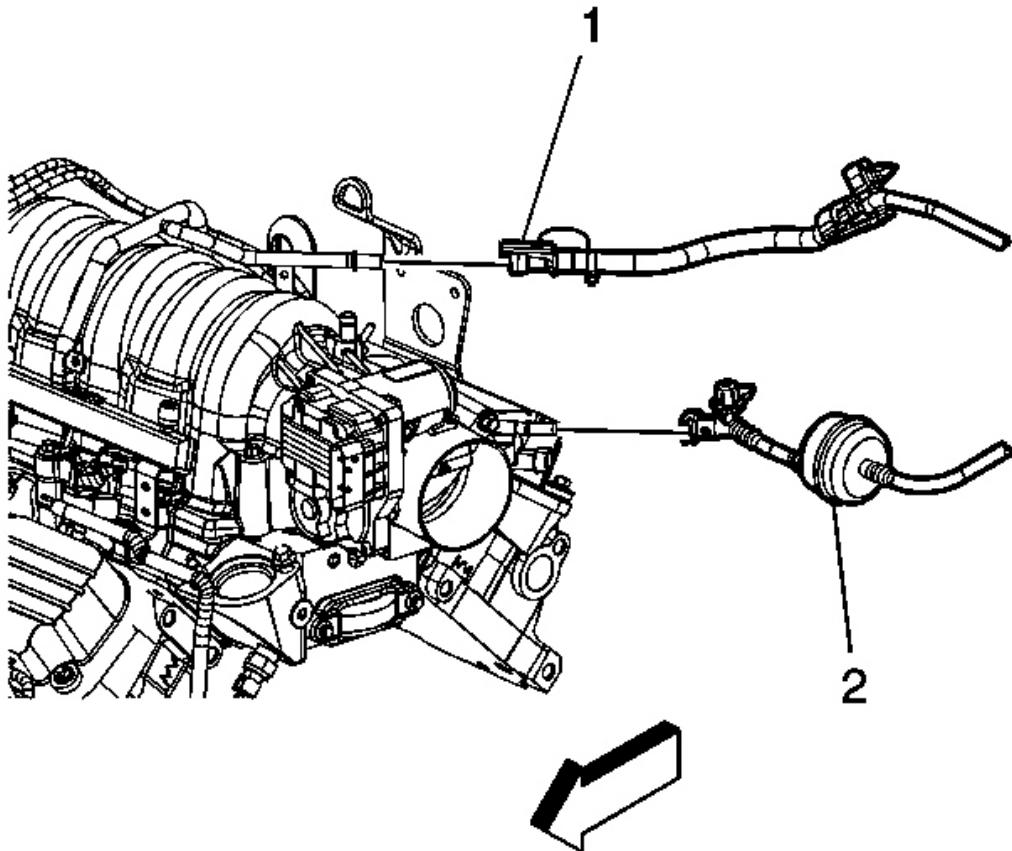
**Fig. 78: Locating Engine Wiring Harness & Heat Shield**  
Courtesy of GENERAL MOTORS CORP.

13. Install the engine wiring harness heat shield.
14. Install the engine wiring harness heat shield nut and bolt.

**Tighten:** Tighten the bolt/nut to 10 N.m (89 lb in).

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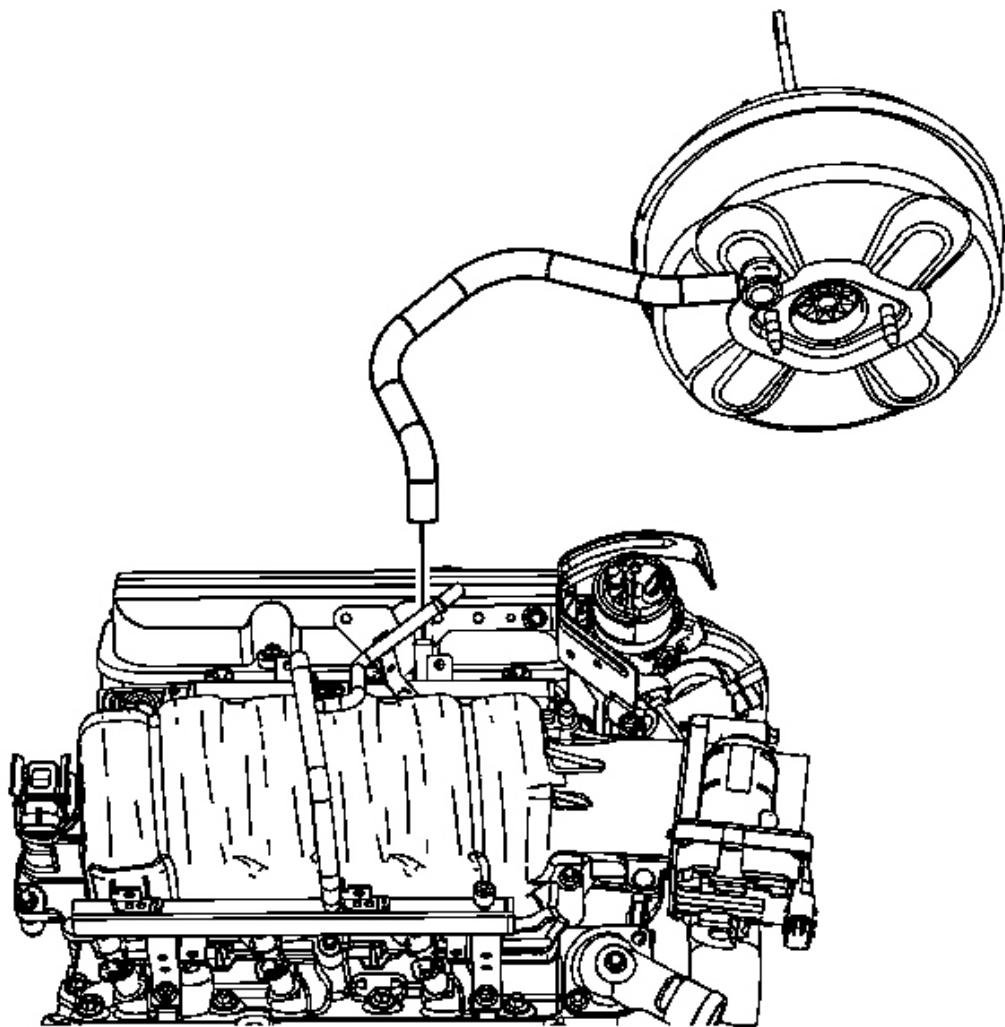


**Fig. 79: Locating Evaporative Emission (EVAP) Pipe Quick Connect Fitting**  
Courtesy of GENERAL MOTORS CORP.

15. Connect the EVAP pipe quick connect fitting (2) to the purge solenoid. Refer to **Plastic Collar Quick Connect Fitting Service**.

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**Fig. 80: View Of Brake Booster Vacuum Hose**

Courtesy of GENERAL MOTORS CORP.

16. Install the brake booster vacuum hose to the upper intake manifold fitting.
17. Install the fuel rail assembly. Refer to [Fuel Injection Fuel Rail Assembly Replacement](#).
18. Install the air cleaner outlet duct.

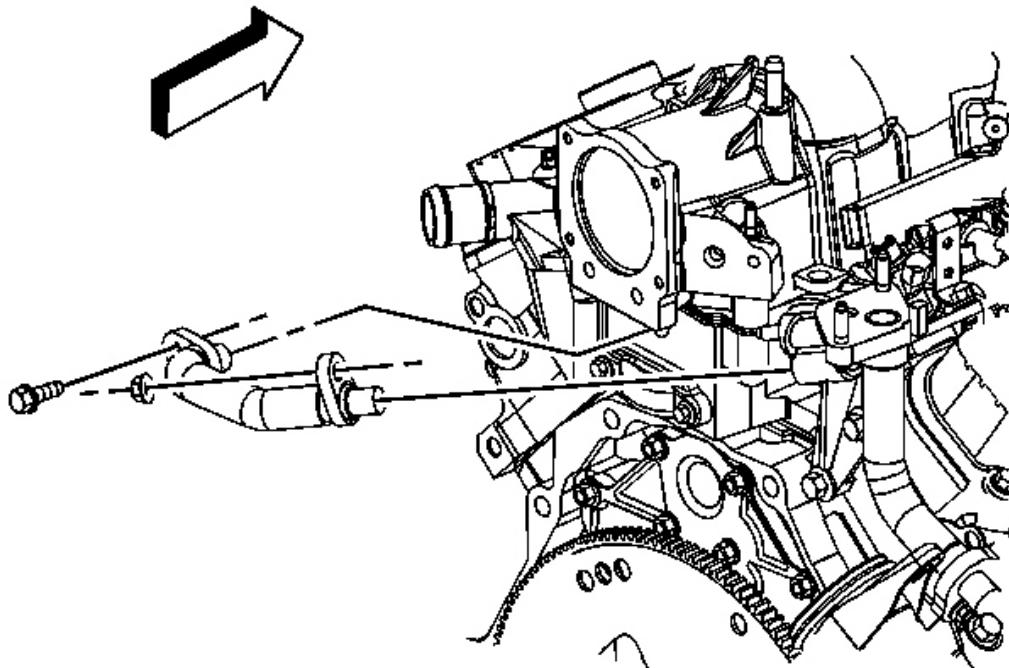
### **LOWER INTAKE MANIFOLD REPLACEMENT**

**Tools Required**

**J 38185** Hose Clamp Pliers. See **Special Tools**.

**Removal Procedure**

1. Remove the upper intake manifold. Refer to **Upper Intake Manifold Replacement**.
2. Remove the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.

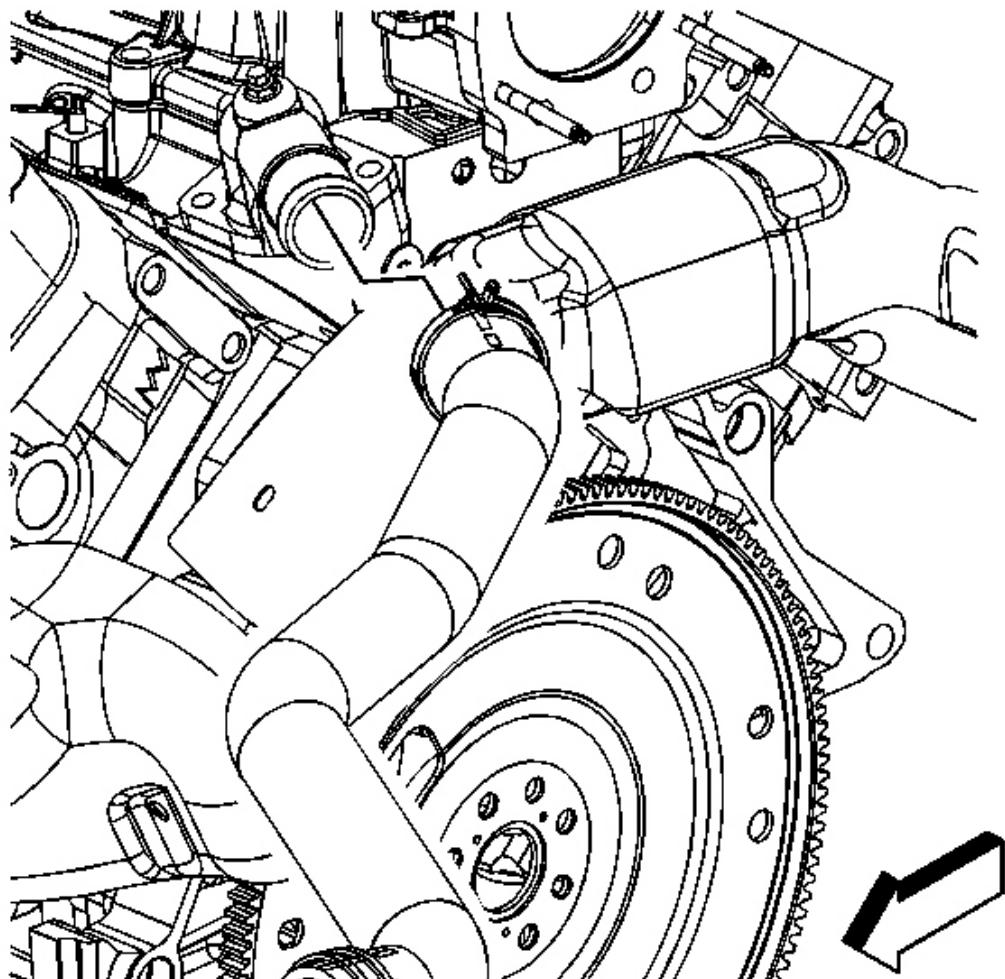


**Fig. 81: View Of EGR Valve Outlet Pipe**  
Courtesy of GENERAL MOTORS CORP.

3. Remove the exhaust gas recirculation (EGR) valve outlet pipe bolt and nut.
4. Remove the EGR valve outlet pipe.

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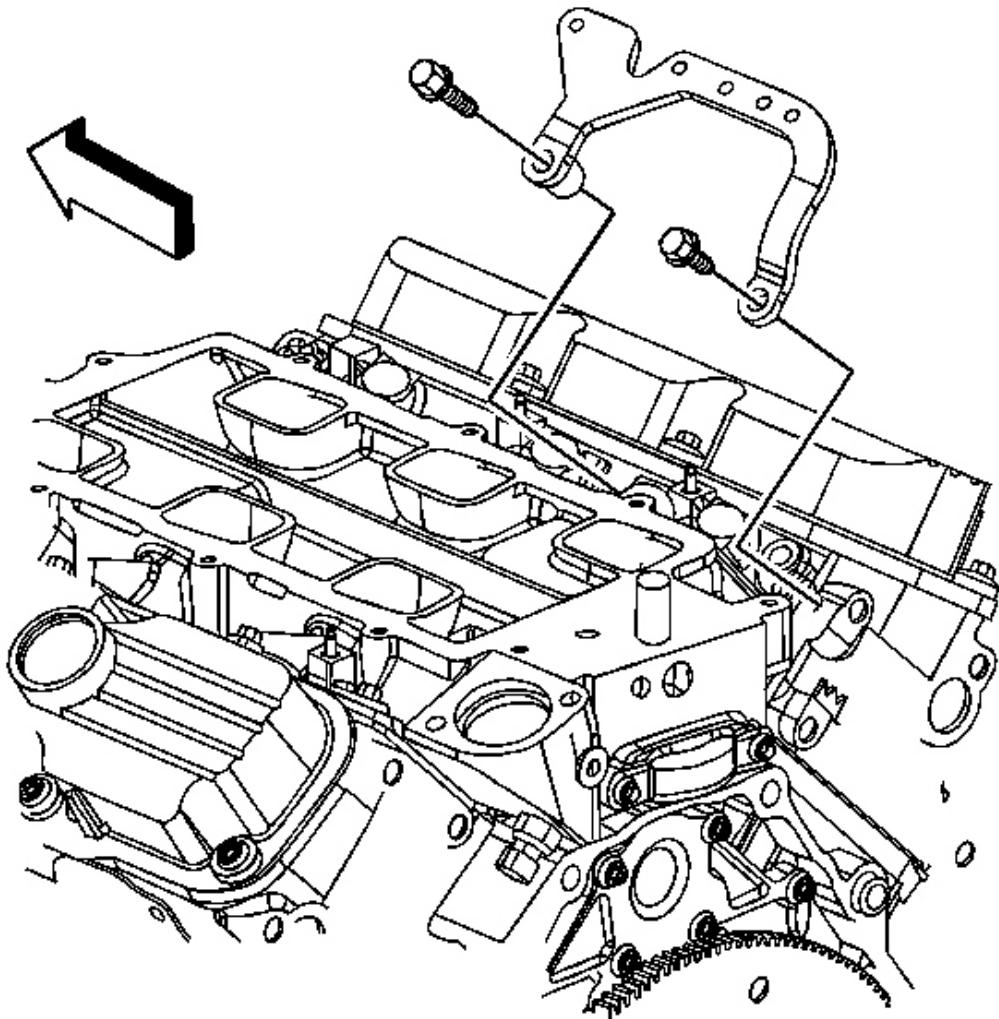
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**Fig. 82: Locating Inlet Hose Clamps**

Courtesy of GENERAL MOTORS CORP.

5. Using the **J 38185** reposition the hose clamp at the thermostat housing. See **Special Tools**.
6. Remove the radiator inlet hose from the thermostat housing.

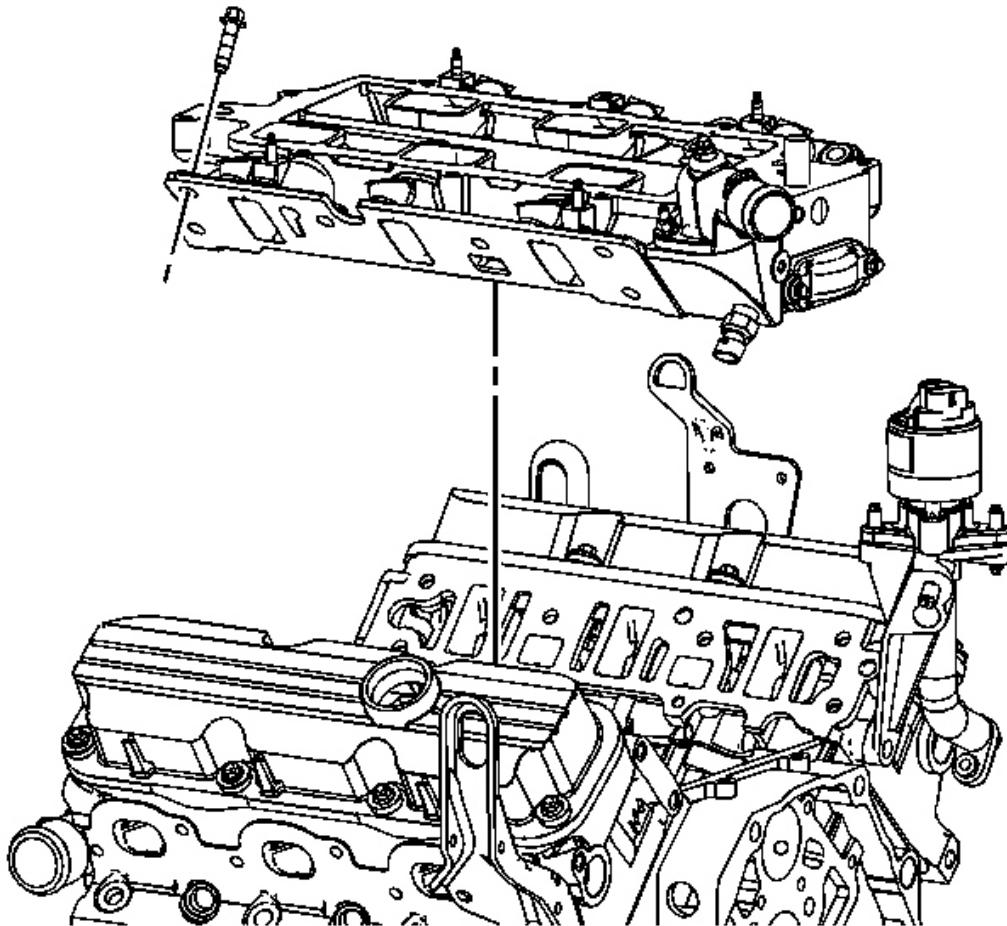


**Fig. 83: Identifying Generator Brace Bracket & Bolts**  
Courtesy of GENERAL MOTORS CORP.

7. Remove the generator brace bracket bolts.
8. Remove the generator brace bracket and spacer.

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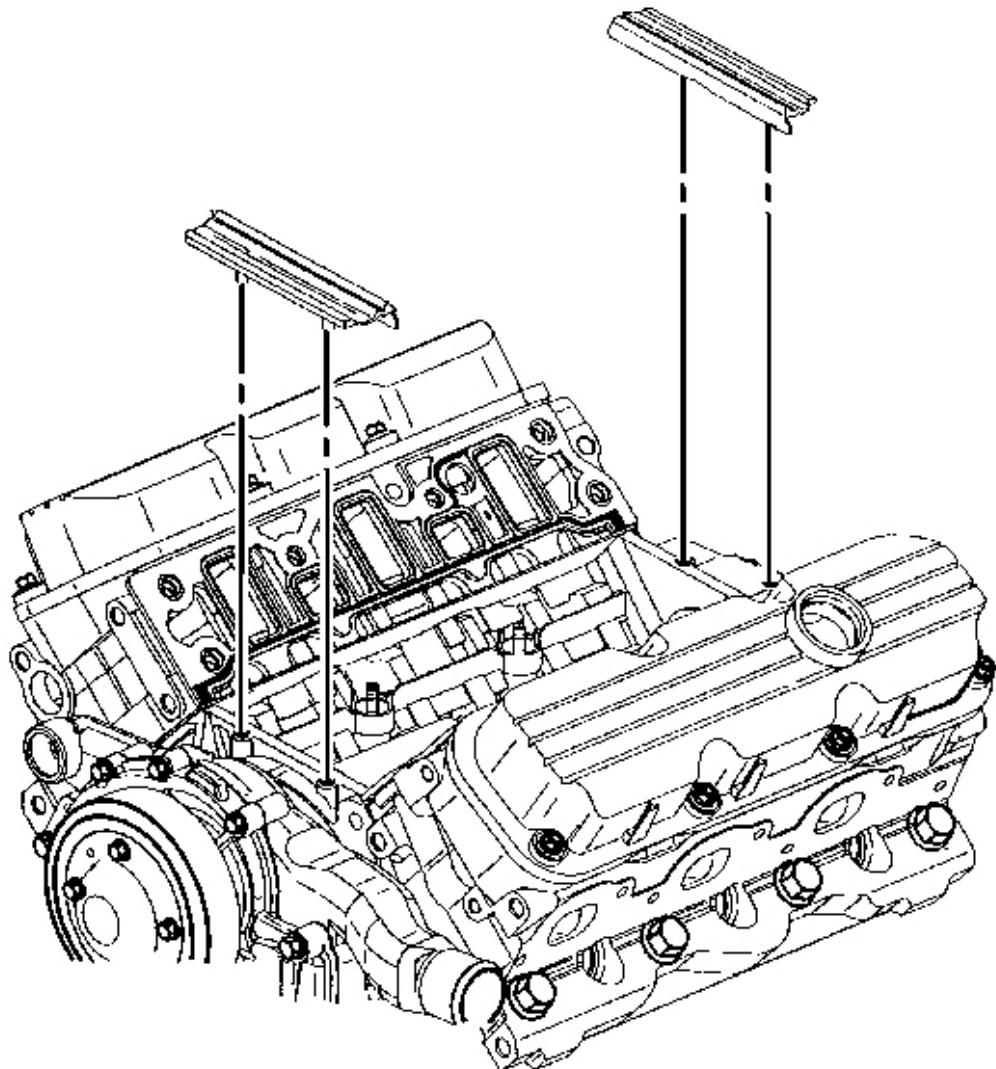


**Fig. 84: Identifying Lower Intake Manifold**  
Courtesy of GENERAL MOTORS CORP.

9. Remove the lower intake manifold bolts.
10. Remove the lower intake manifold.

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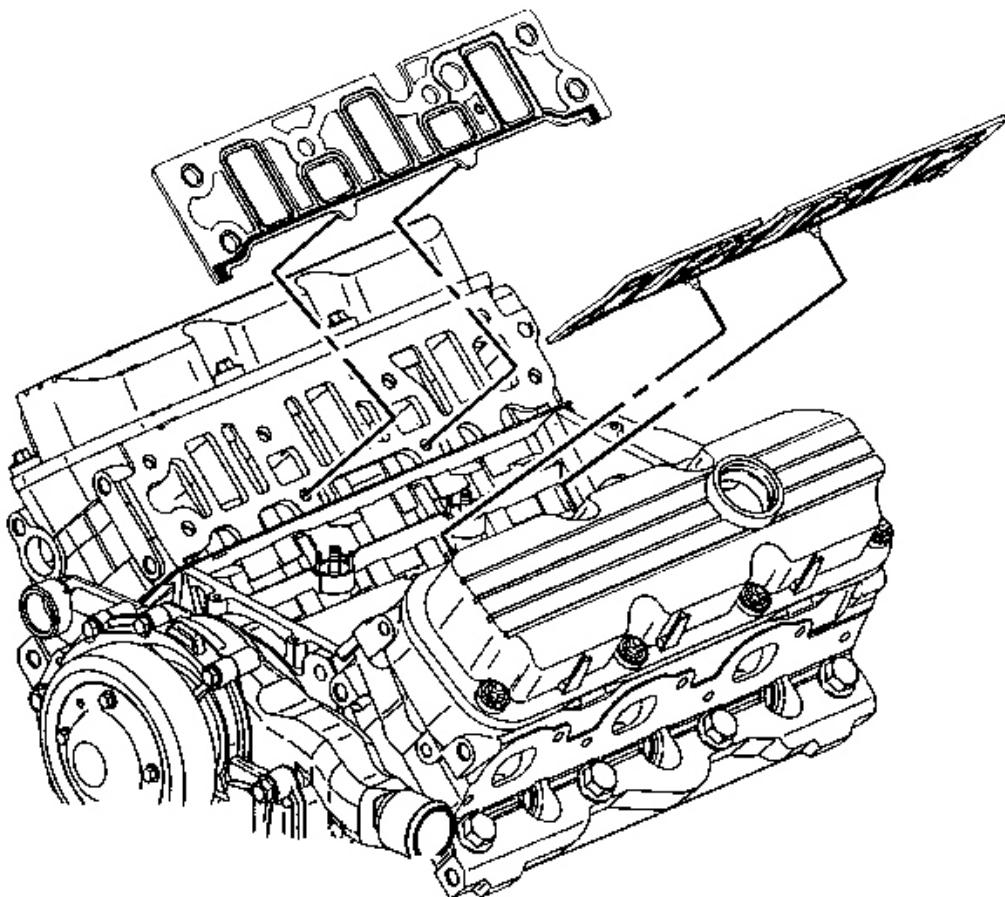


**Fig. 85: Lower Intake Manifold Seals**  
Courtesy of GENERAL MOTORS CORP.

11. Remove the lower intake manifold seals.

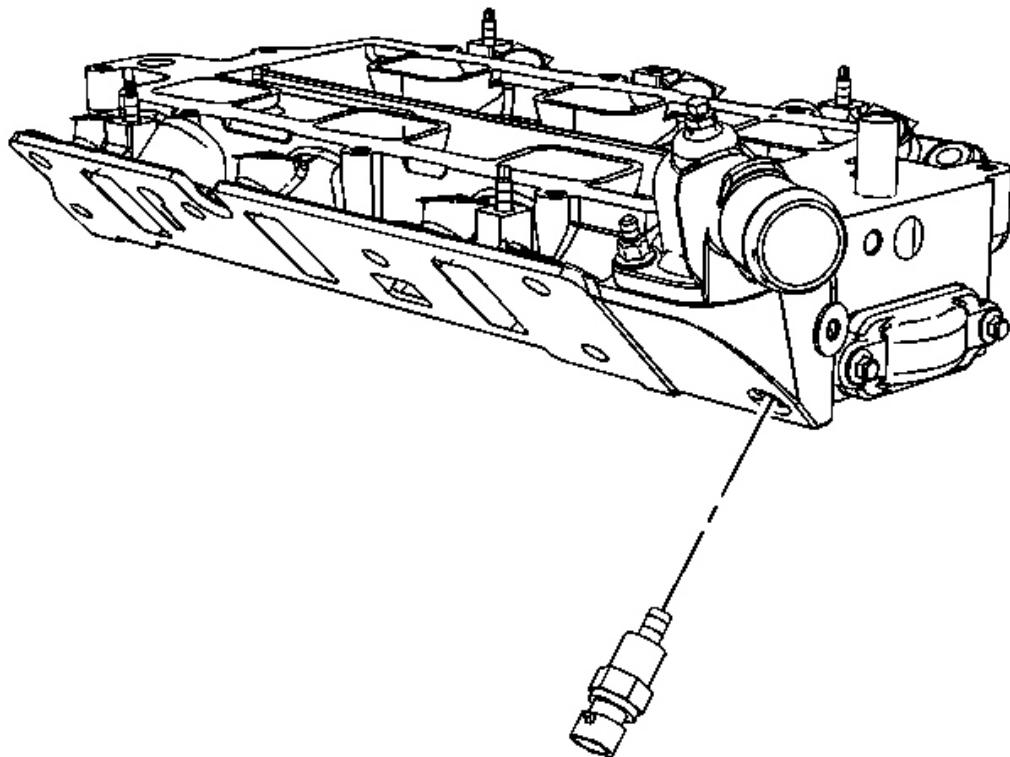
**2006 Buick Lucerne CXS**

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**Fig. 86: View Of Lower Intake Manifold Gaskets**  
Courtesy of GENERAL MOTORS CORP.

12. Remove the lower intake manifold gaskets.

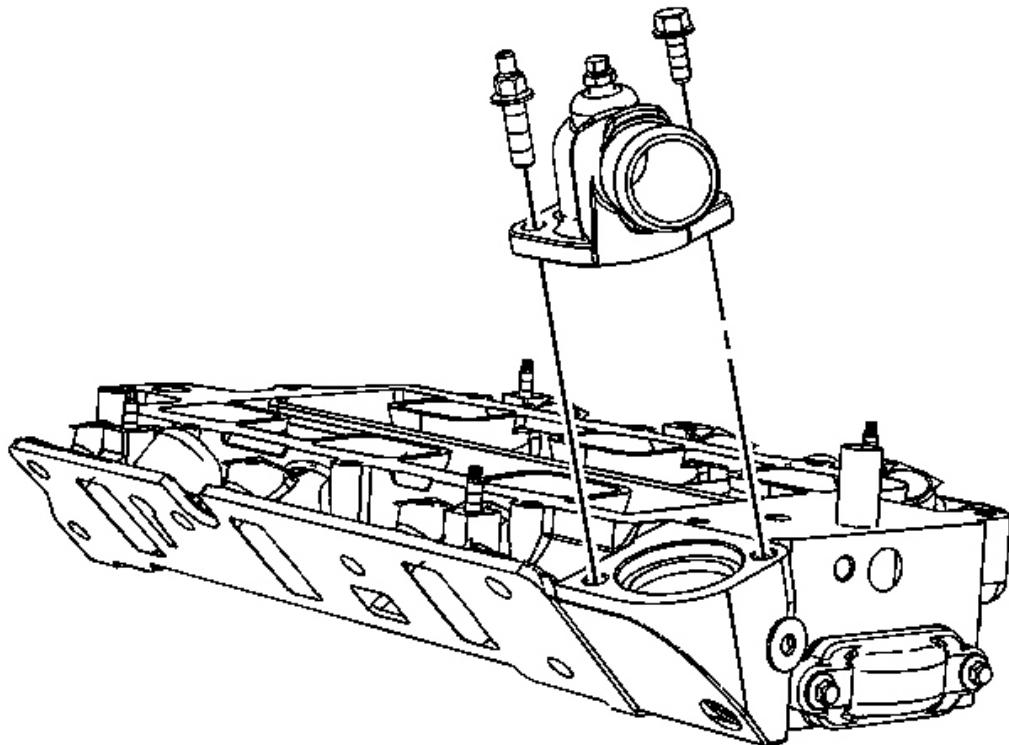


**Fig. 87: Locating Engine Coolant Temperature (ECT) Sensor**  
Courtesy of GENERAL MOTORS CORP.

13. If replacing the lower intake manifold perform the following steps, otherwise proceed to step 5 in the installation procedure.
14. Remove the engine coolant temperature (ECT) sensor.

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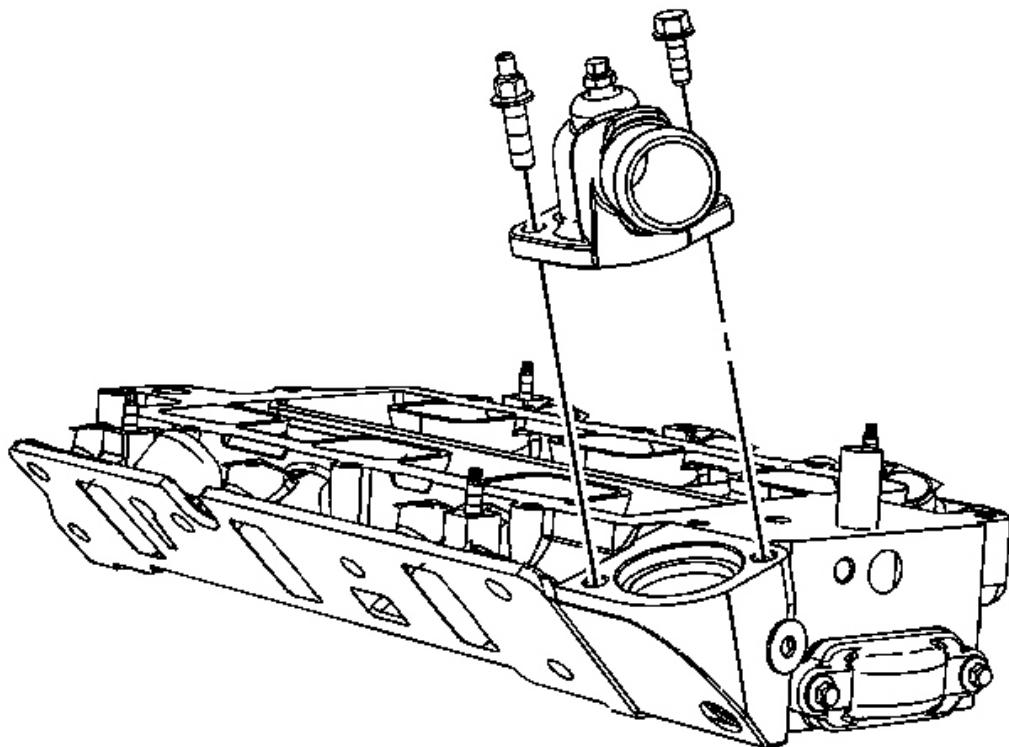
2006 ENGINE Engine Mechanical - 3.8L - Lucerne



**Fig. 88: Identifying Thermostat Housing Bolt & Stud**  
Courtesy of GENERAL MOTORS CORP.

15. Remove the thermostat housing bolt and stud.
16. Remove the thermostat housing and thermostat.

### Installation Procedure



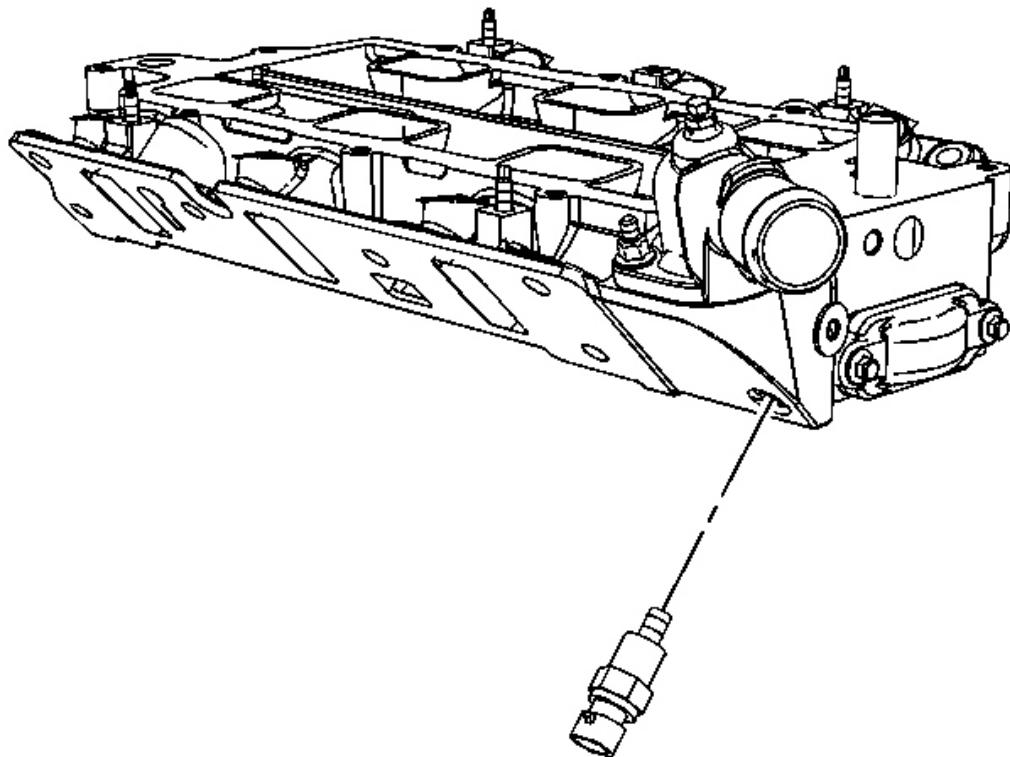
**Fig. 89: Identifying Thermostat Housing Bolt & Stud**  
Courtesy of GENERAL MOTORS CORP.

1. If replacing the lower intake manifold perform the following steps, otherwise proceed to step 5.
2. Install the thermostat and housing.

**NOTE: Refer to Fastener Notice .**

3. Install the thermostat housing bolt and stud.

**Tighten:** Tighten the bolt/stud to 25 N.m (18 lb ft).



**Fig. 90: View Of Engine Coolant Temperature (ECT) Sensor**  
Courtesy of GENERAL MOTORS CORP.

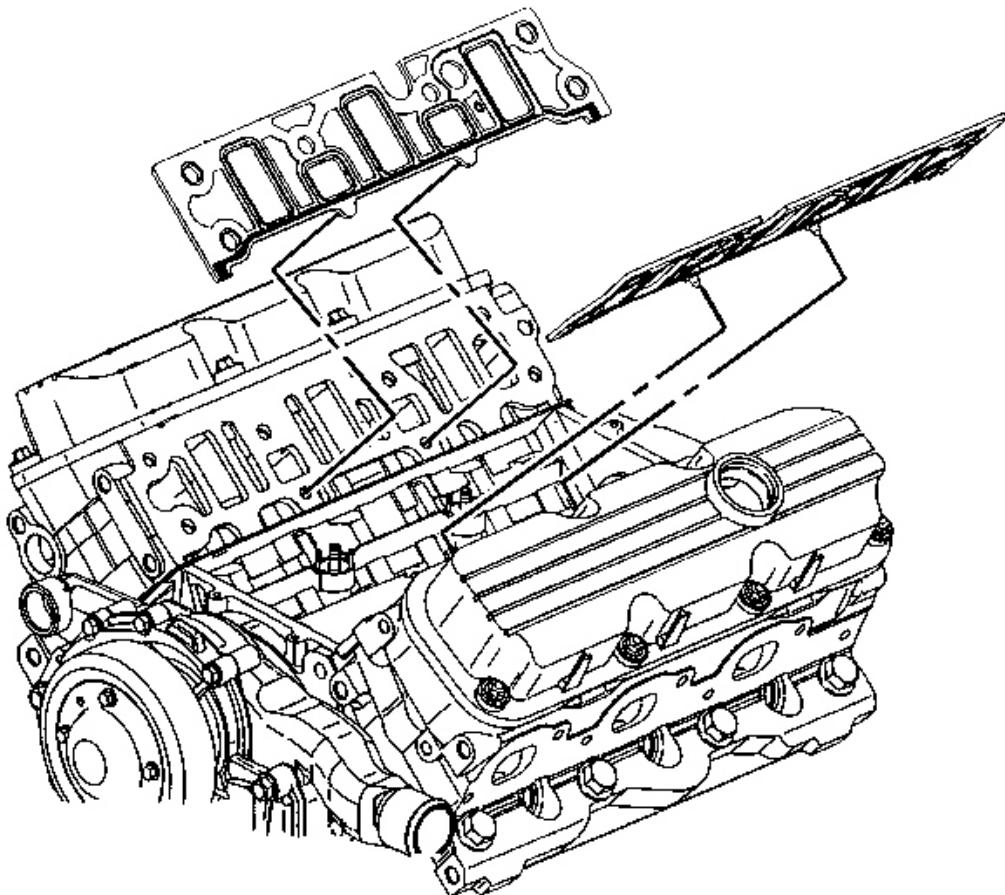
4. Install the ECT sensor.

**Tighten:** Tighten the sensor to 23 N.m (17 lb ft).

5. Clean the lower intake manifold sealing surface prior to installing the seals or gaskets. Refer to **Sealers, Adhesives and Lubricants** for the correct part number.

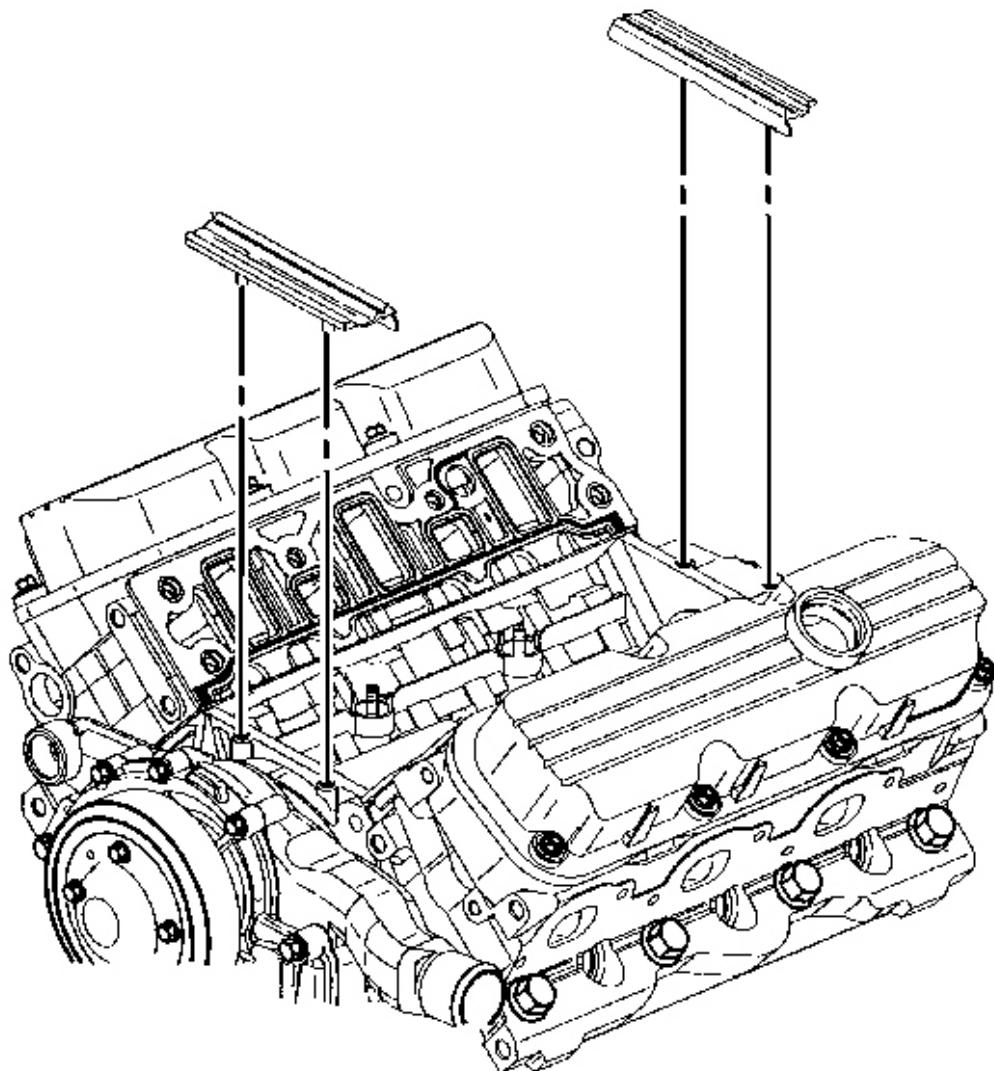
**2006 Buick Lucerne CXS**

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**Fig. 91: View Of Lower Intake Manifold Gaskets**  
Courtesy of GENERAL MOTORS CORP.

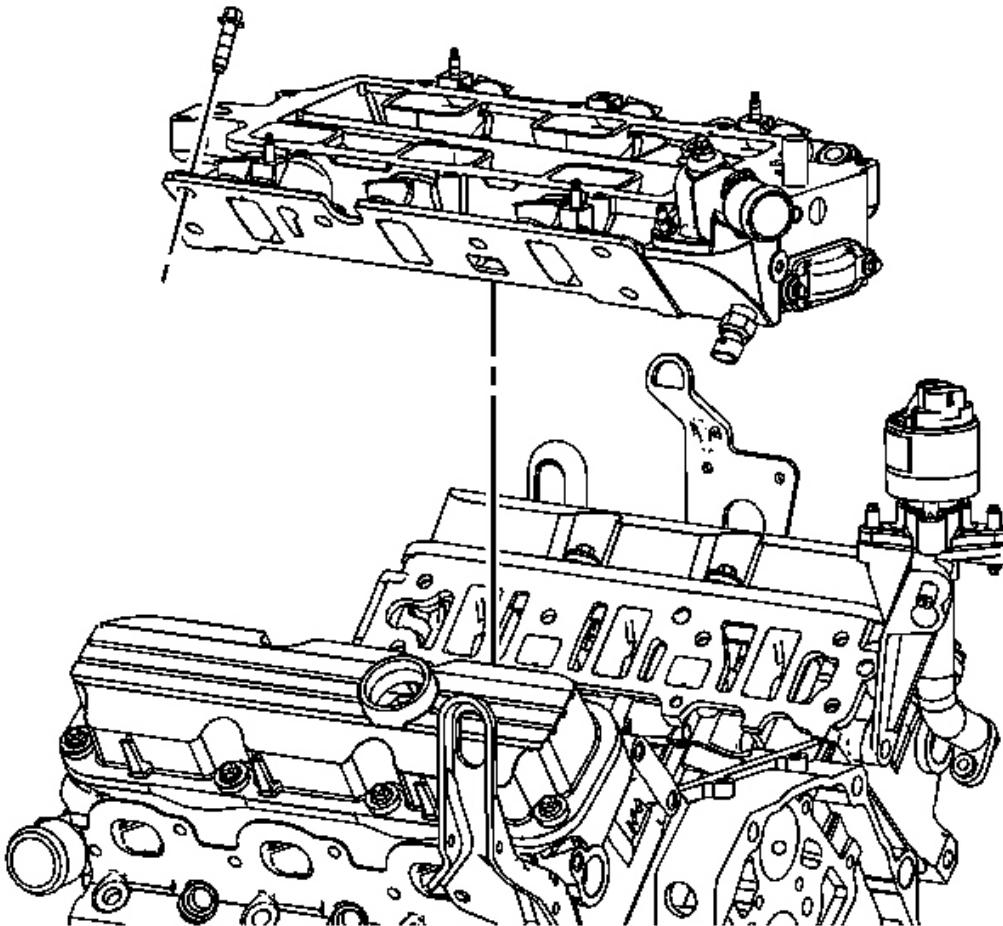
6. Install the lower intake manifold gaskets.



**Fig. 92: Lower Intake Manifold Seals**

Courtesy of GENERAL MOTORS CORP.

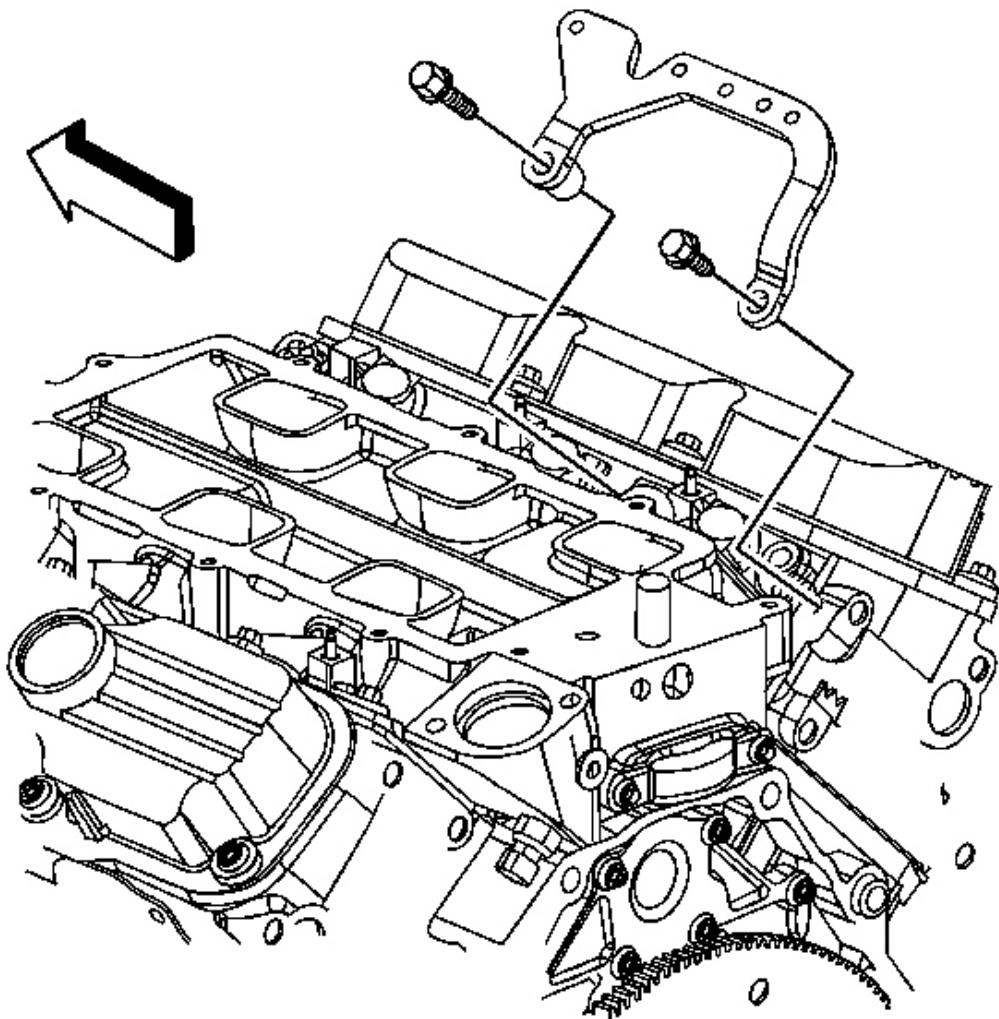
7. Apply sealer to the ends of the intake manifold seals. Refer to **Sealers, Adhesives and Lubricants** for the correct part number.
8. Install the lower intake manifold seals.



**Fig. 93: Identifying Lower Intake Manifold**  
Courtesy of GENERAL MOTORS CORP.

9. Install the lower intake manifold.
10. Apply threadlock to the lower intake manifold bolt threads. Refer to [Sealers, Adhesives and Lubricants](#) for the correct part number.
11. Install the lower intake manifold bolts.

**Tighten:** Tighten the bolts to 15 N.m (11 lb ft).



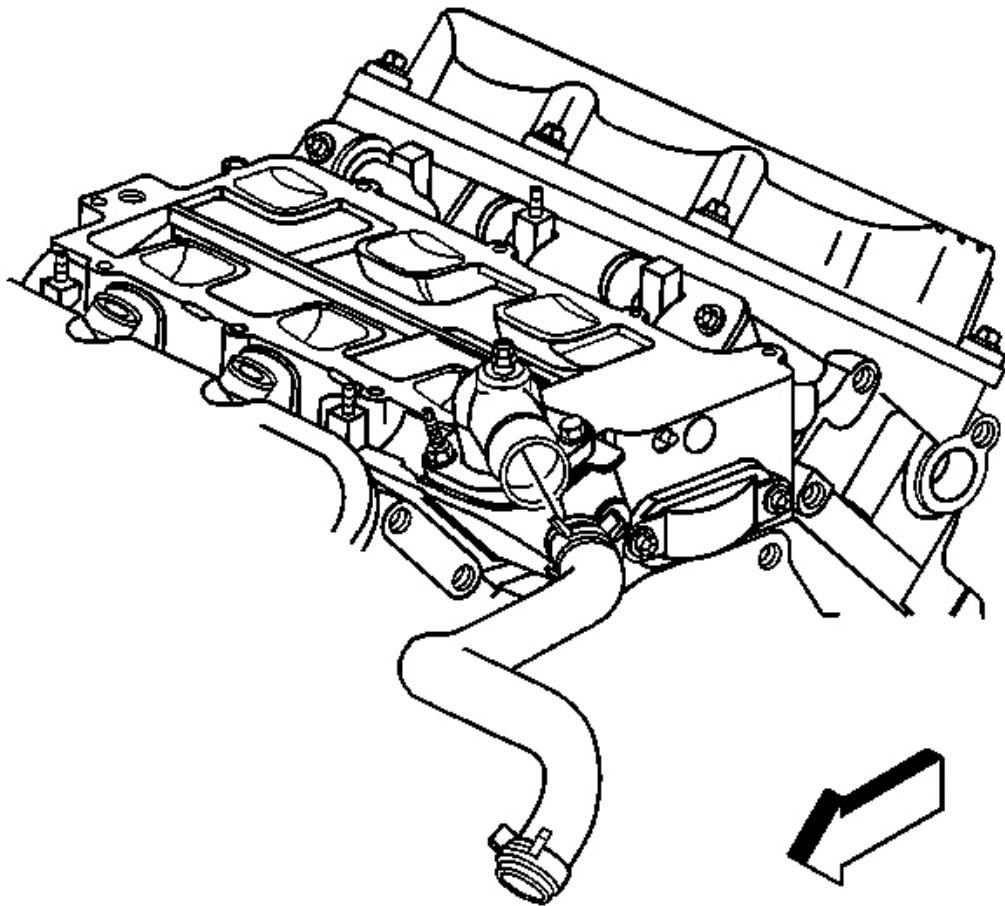
**Fig. 94: Identifying Generator Brace Bracket & Bolts**  
Courtesy of GENERAL MOTORS CORP.

12. Install the generator brace bracket and spacer.
13. Install the generator brace bracket bolts.

**Tighten:** Tighten the bolts to 50 N.m (37 lb ft).

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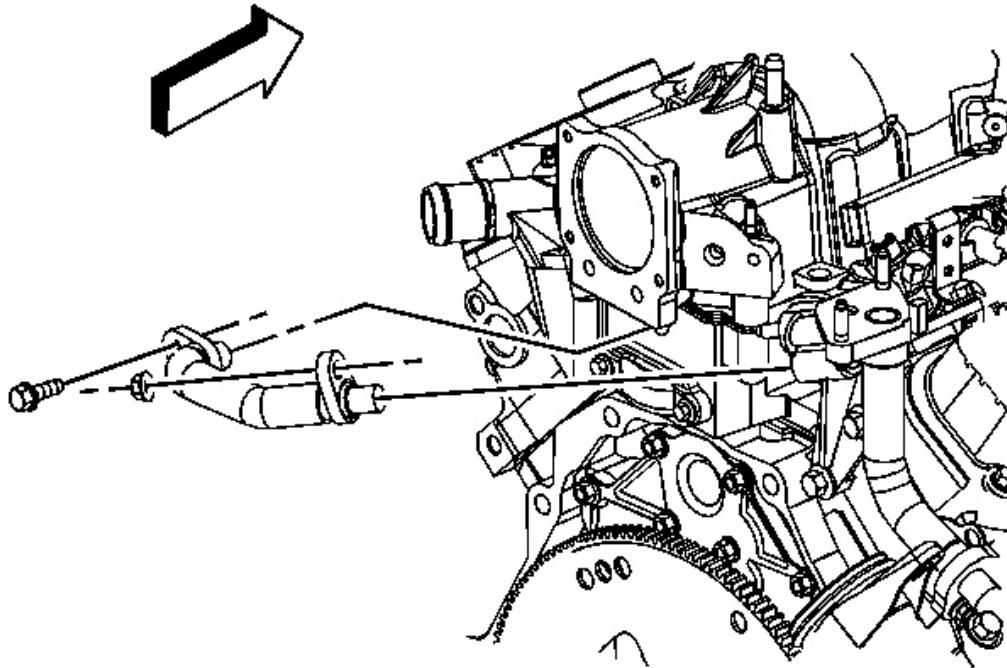
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**Fig. 95: Radiator Inlet Hose**

Courtesy of GENERAL MOTORS CORP.

14. Install the radiator inlet hose to the thermostat housing.
15. Using the **J 38185** position the hose clamp at the thermostat housing. See **Special Tools**.



**Fig. 96: View Of EGR Valve Outlet Pipe**  
Courtesy of GENERAL MOTORS CORP.

16. Install the EGR valve outlet pipe.
17. Install the EGR valve outlet pipe bolt and nut.

**Tighten:** Tighten the bolt/nut to 25 N.m (18 lb ft).

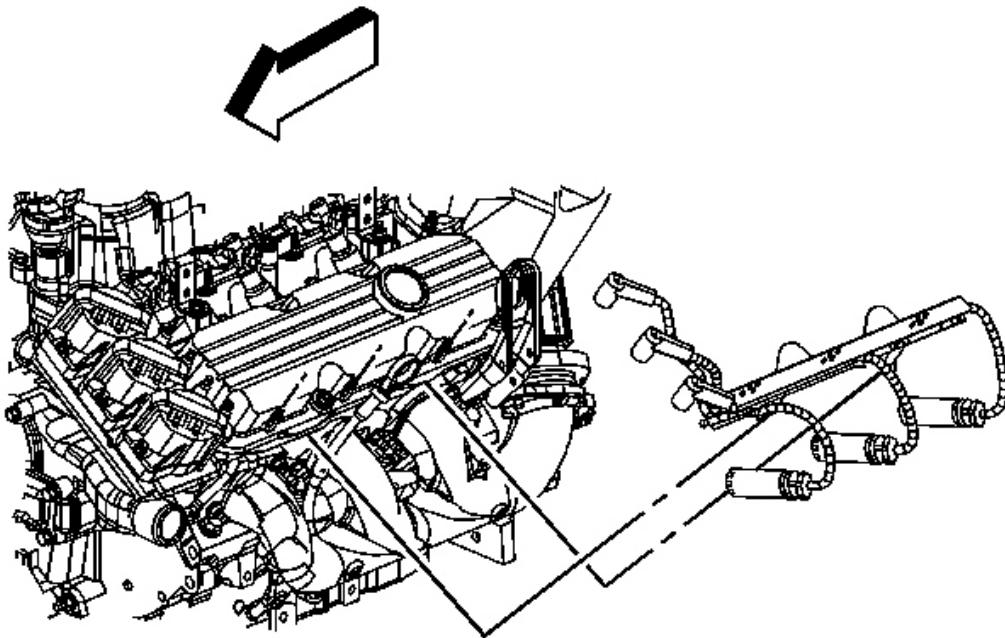
18. Install the drive belt tensioner. Refer to [Drive Belt Tensioner Replacement](#).
19. Install the upper intake manifold. Refer to [Upper Intake Manifold Replacement](#).

#### **VALVE ROCKER ARM COVER REPLACEMENT - LEFT SIDE**

##### **Tools Required**

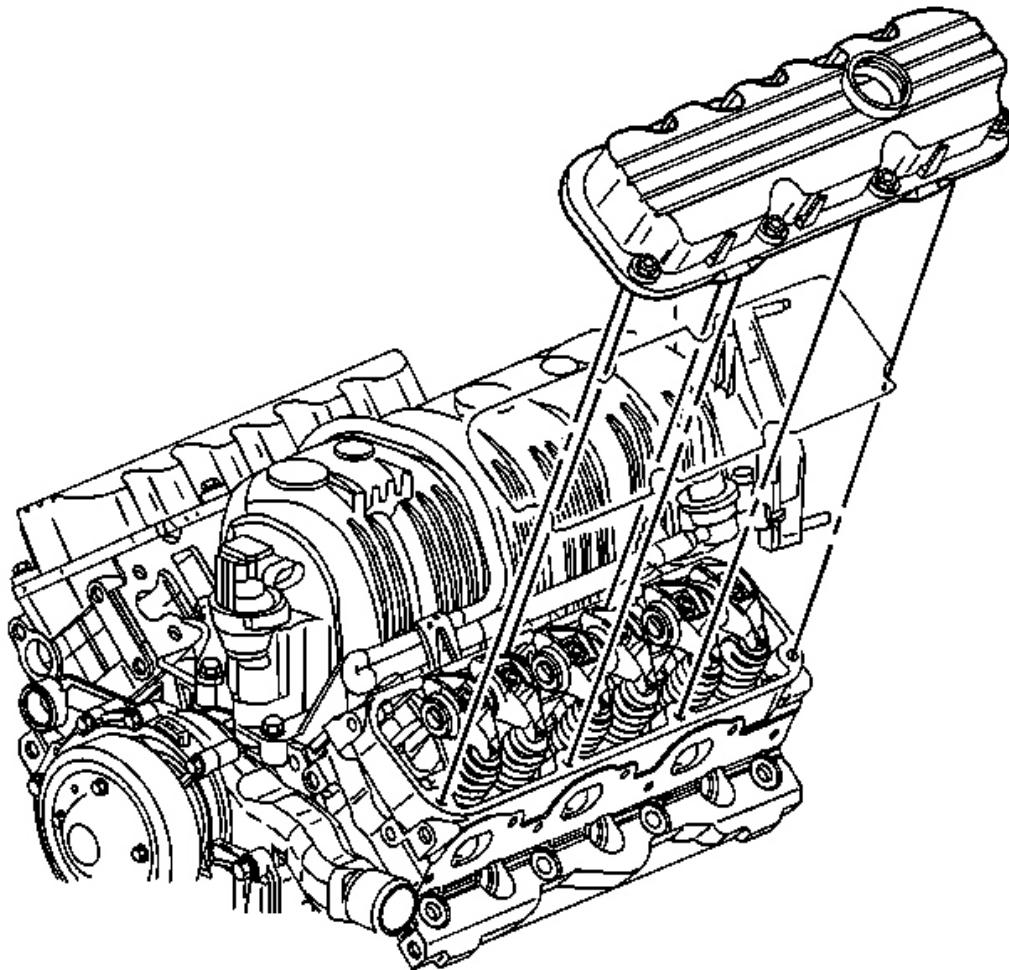
**J 38491** Spark Plug Boot Removal Tool. See [Special Tools](#).

##### **Removal Procedure**



**Fig. 97: View Of Left Spark Plugs Wires & Ignition Coils**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the intake manifold cover. Refer to [Intake Manifold Cover Replacement](#).
2. Remove the spark plugs from the ignition coils.
3. Twist the spark plug boot 1/2 turn before removing the boot.
4. Using the **J 38491**, gently pry the heat shield up from the spark plugs. See [Special Tools](#).
5. Remove the spark plug wires from the spark plugs.
6. Remove the spark plug harness tabs from the rocker cover and remove the harness.



**Fig. 98: Locating Left Valve Rocker Arm Cover**

Courtesy of GENERAL MOTORS CORP.

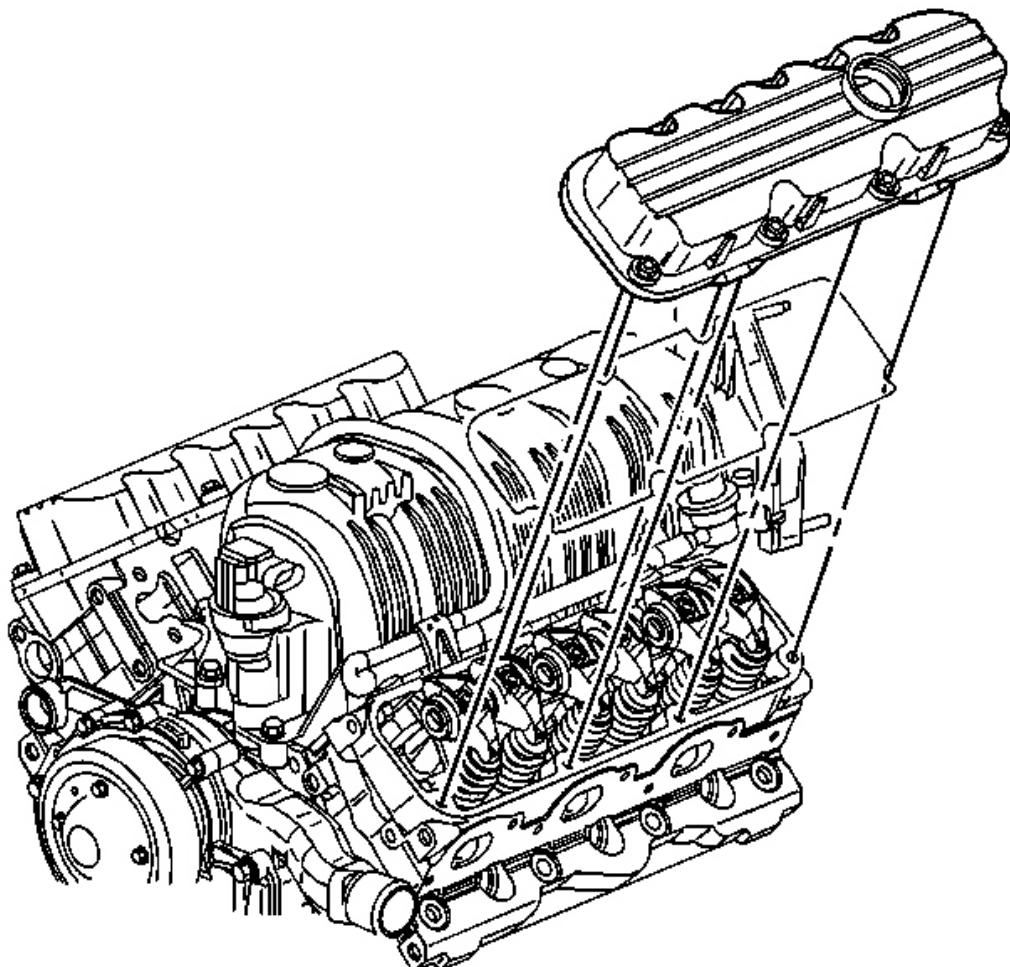
7. Remove the valve rocker arm cover bolts.

**IMPORTANT: If the valve rocker arm cover adheres to the cylinder head, remove the cover by bumping the end of the cover with the palm of your hand or with a soft rubber mallet.**

8. Remove the valve rocker arm cover.
9. Remove the valve rocker arm cover gasket.

10. Clean the valve rocker arm cover mating surfaces.
11. Clean the valve rocker arm cover bolts of all thread locking adhesive.

**Installation Procedure**



**Fig. 99: Locating Left Valve Rocker Arm Cover**

Courtesy of GENERAL MOTORS CORP.

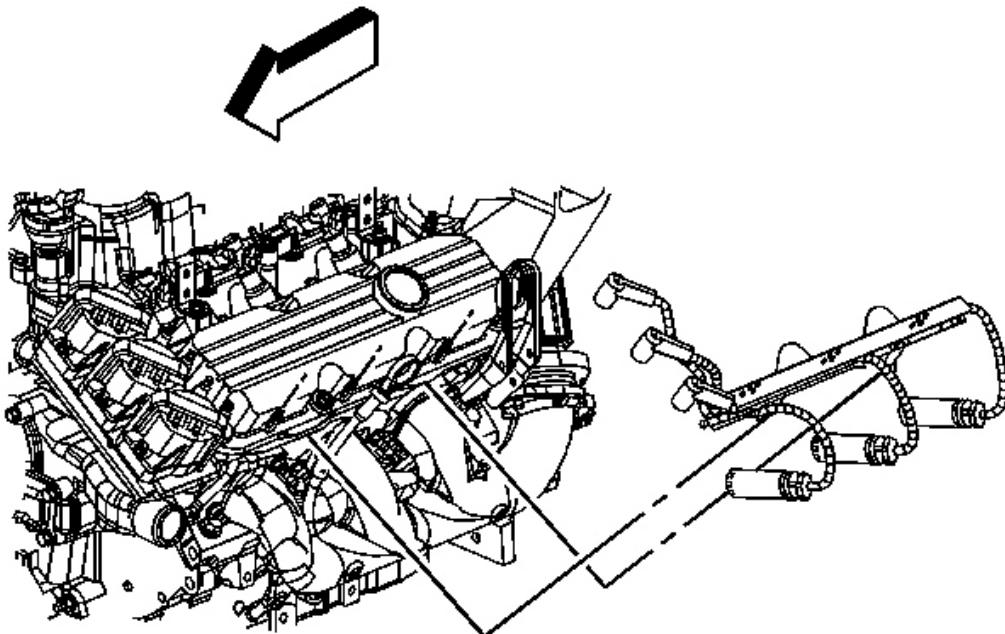
1. Install a NEW valve rocker arm cover gasket. Ensure that gasket is seated properly in the cover groove.
2. Install the left valve rocker arm cover.

3. Apply threadlock to the valve rocker arm cover bolt threads. Refer to [Sealers, Adhesives and Lubricants](#) for the correct part number.

**NOTE:** Refer to [Fastener Notice](#) .

4. Install the valve rocker arm cover bolts.

**Tighten:** Tighten the bolts to 10 N.m (89 lb in).



**Fig. 100: View Of Left Spark Plugs, Wires & Ignition Coils**  
Courtesy of GENERAL MOTORS CORP.

5. Install the spark plug wires to the spark plugs.
6. Install the spark plugs to the ignition coil.
7. Install the spark plug harness tabs to the rocker cover.
8. Install the intake manifold cover. Refer to [Intake Manifold Cover Replacement](#).
9. Check and fill the crankcase if necessary.
10. Inspect for oil leaks.

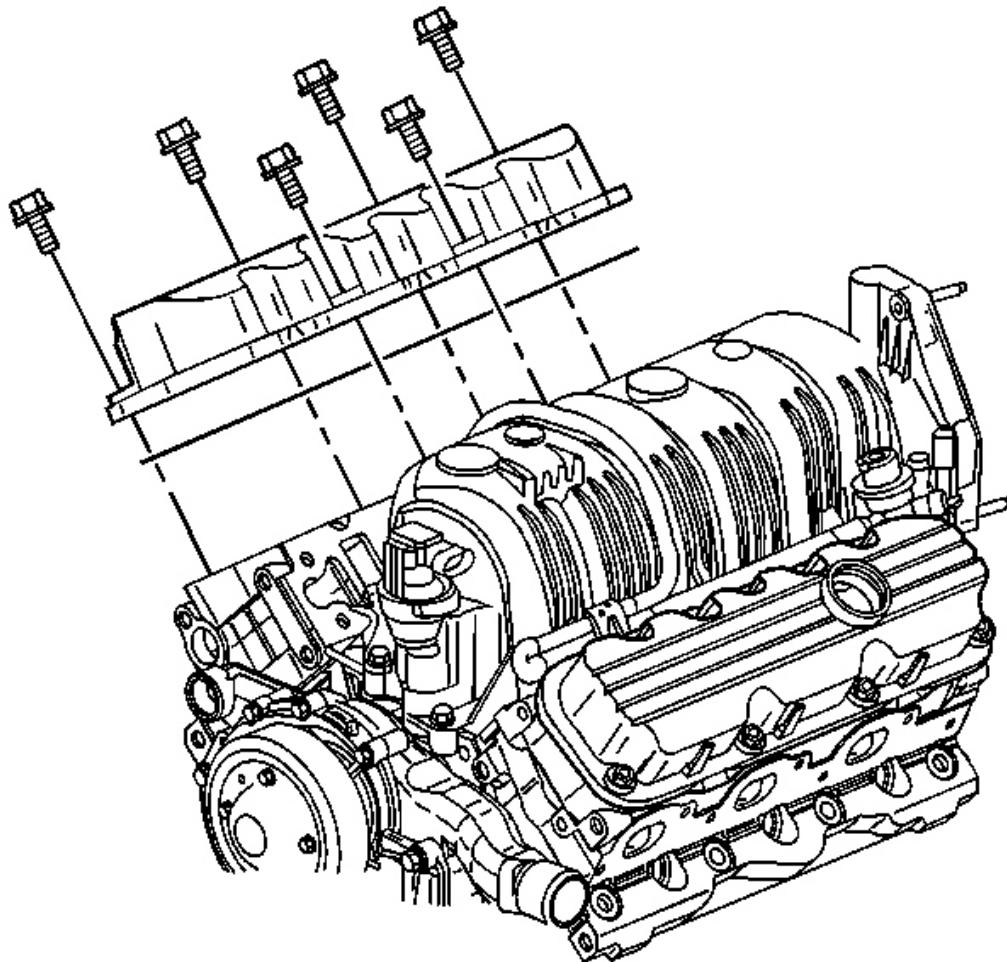
## VALVE ROCKER ARM COVER REPLACEMENT - RIGHT SIDE

### Removal Procedure

1. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Disconnect the right spark plug wires from the spark plugs and coils. Refer to [Spark Plug Wire Replacement](#).
3. Remove the right spark plug wires and cover from the right valve rocker arm cover.
4. On supercharged models, disconnect the hoses and electrical connector from the evaporative emission (EVAP) canister purge solenoid located above the right valve rocker arm cover.
5. On supercharged models, remove the EVAP canister purge valve from the EVAP canister purge valve mounting bracket.

**IMPORTANT: It is not necessary to remove the heater hoses from the drive belt tensioner. When the tensioner has been removed from the engine, it can be repositioned out of the way with the hoses still attached.**

6. Remove the drive belt tensioner. Refer to [Drive Belt Tensioner Replacement](#).



**Fig. 101: View Of Right Side Valve Rocker Arm Cover**  
Courtesy of GENERAL MOTORS CORP.

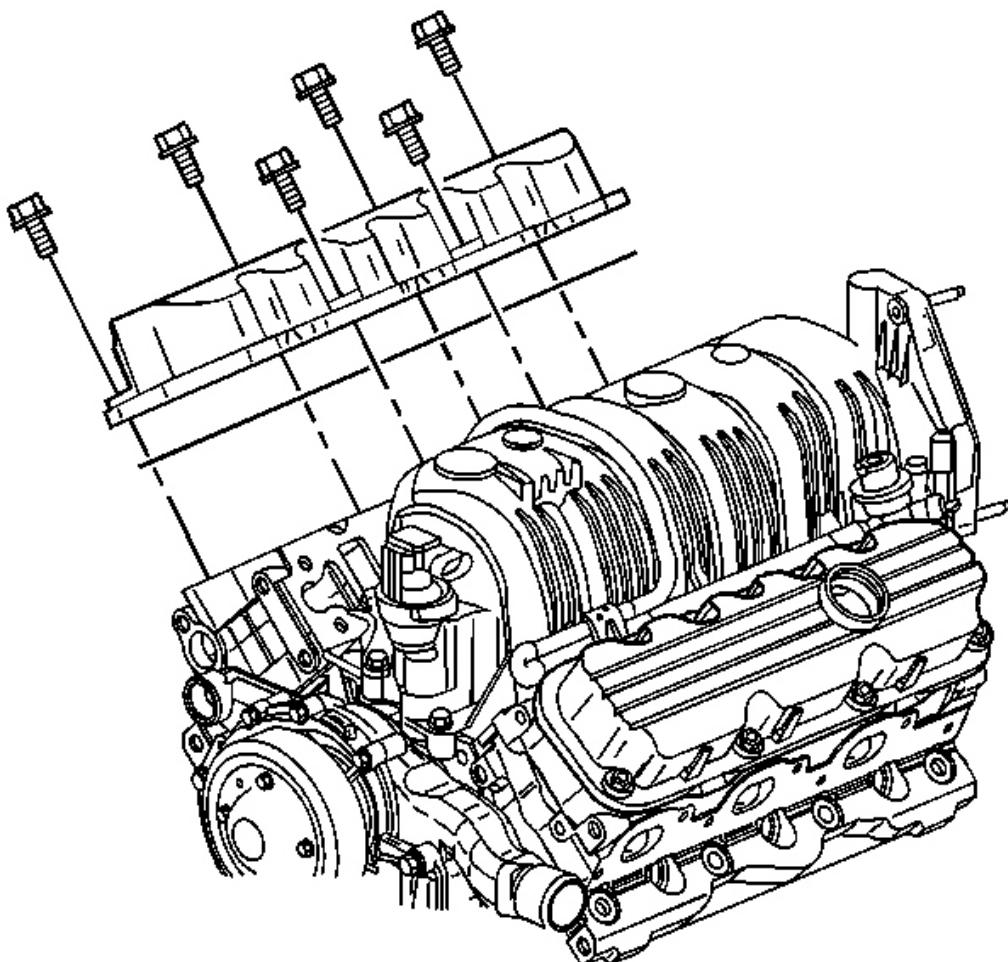
7. Remove the right valve rocker arm cover bolts.

**IMPORTANT: If the valve rocker arm cover adheres to the cylinder head, remove the valve rocker arm cover by bumping the end of the valve rocker arm cover with the palm of your hand or a soft rubber mallet.**

8. Remove the right valve rocker arm cover.

9. Remove the right valve rocker arm cover gasket.
10. Clean the sealing surface on the cylinder head.
11. Clean the valve rocker arm cover bolts of all thread locking adhesive.
12. Clean and inspect the valve rocker arm cover. Refer to **Valve Rocker Arm Cover Cleaning and Inspection.**

**Installation Procedure**



**Fig. 102: View Of Right Side Valve Rocker Arm Cover**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT: Ensure the valve rocker arm cover gasket is seated properly in the valve rocker arm cover groove.**

1. Install the new valve rocker arm cover gasket.
2. Install the right valve rocker arm cover to the cylinder head.
3. Apply thread lock compound GM P/N 12345493 (Canadian P/N 10953488) or equivalent, to the valve rocker arm cover bolt threads.

**NOTE: Refer to Fastener Notice .**

4. Install the right valve rocker arm cover bolts.

**Tighten:** Tighten the valve rocker arm cover bolts to 10 N.m (89 lb in).

5. Install the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.
6. On supercharged models, install the EVAP canister purge valve on the EVAP canister purge valve mounting bracket.
7. On supercharged models, connect the electrical connector and hoses to the EVAP solenoid.
8. Install the right spark plug wires and cover to the left valve rocker arm cover.
9. Connect the right spark plug wires to the spark plugs and coils. Refer to **Spark Plug Wire Replacement**.
10. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** or **Cooling System Draining and Filling (Vac-N-Fill)** .
11. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
12. Inspect for oil leaks.

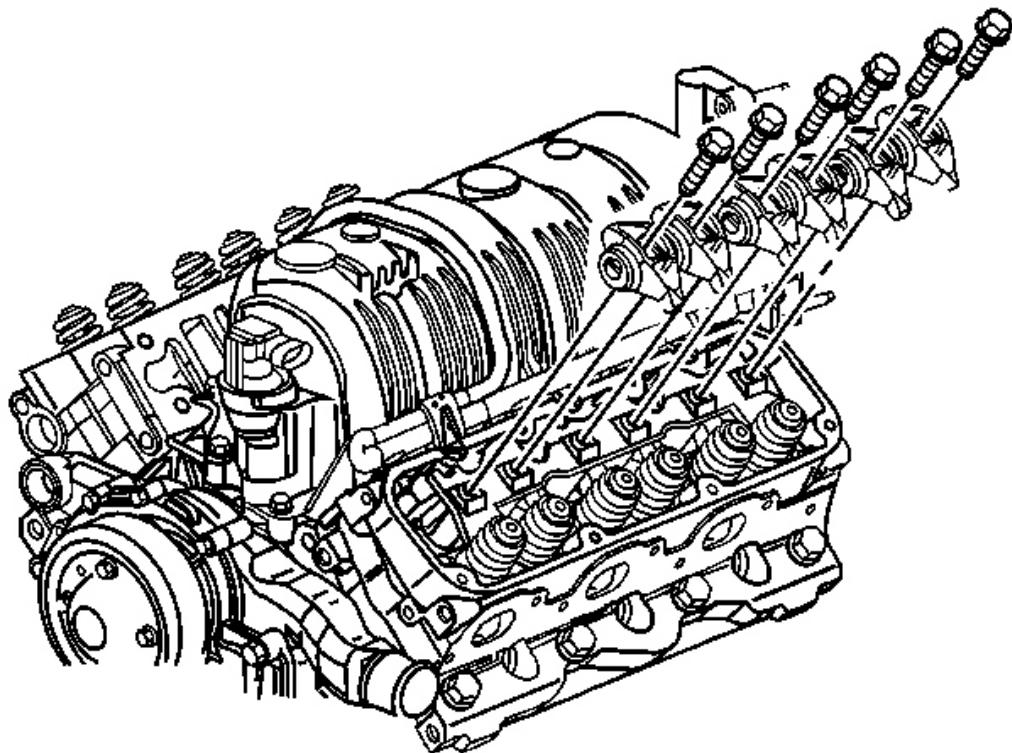
## VALVE ROCKER ARM AND PUSH ROD REPLACEMENT

### Tools Required

**J 45059** Torque Angle Meter. See **Special Tools**.

### Removal Procedure

1. Remove the valve rocker arm cover(s). Refer to **Valve Rocker Arm Cover Replacement - Left Side** and/or **Valve Rocker Arm Cover Replacement - Right Side**.

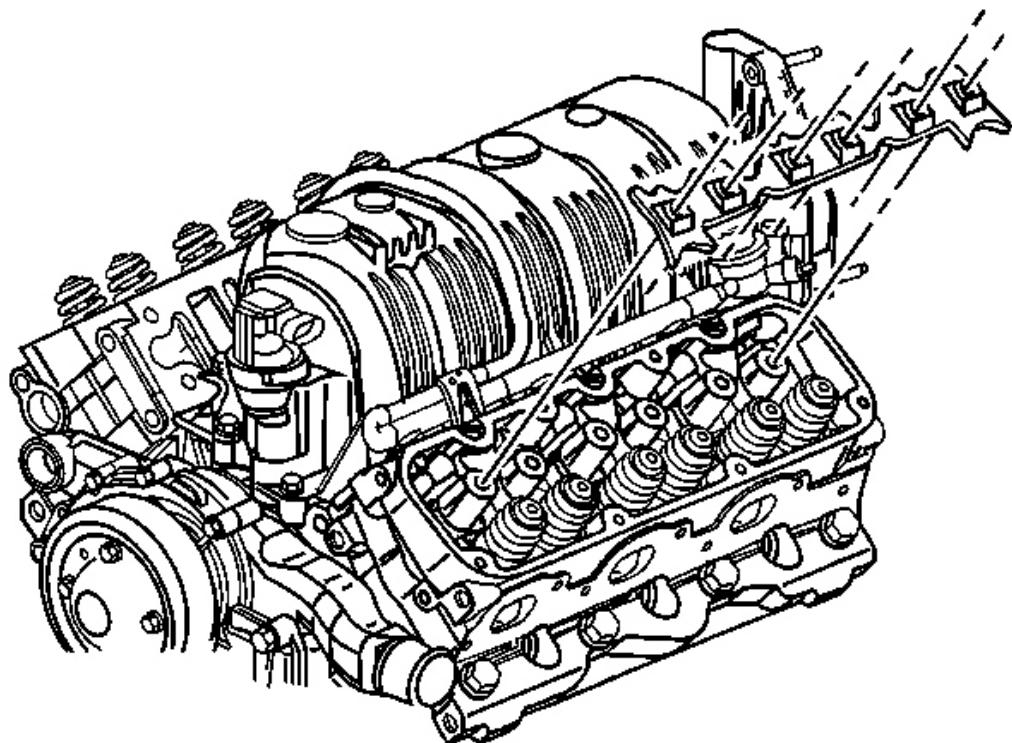


**Fig. 103: View Of Rocker Arm & Bolts**  
Courtesy of GENERAL MOTORS CORP.

2. Remove the valve rocker arm bolt(s).

**IMPORTANT: Place the parts on a clean surface. Store the components in order so they can be reassembled in the same location and with the same mating surfaces as when removed.**

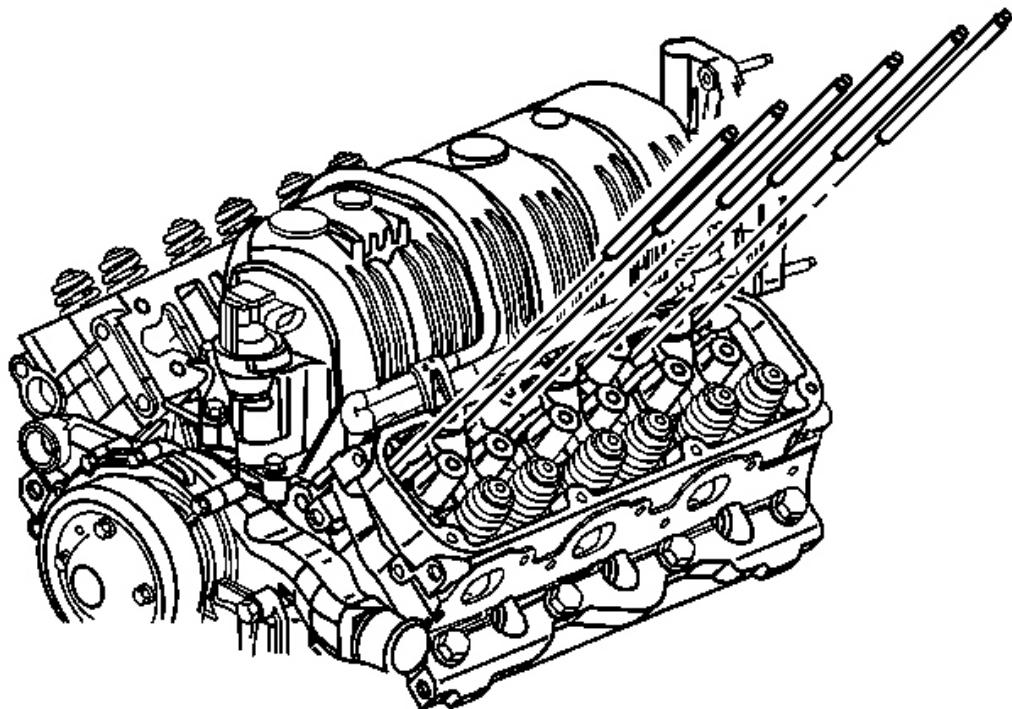
3. Remove the valve rocker arm(s).



**Fig. 104: Identifying Push Rod Guide Plates**

Courtesy of GENERAL MOTORS CORP.

4. Remove the valve rocker arm guide plate, if all of the rocker arms are being removed.



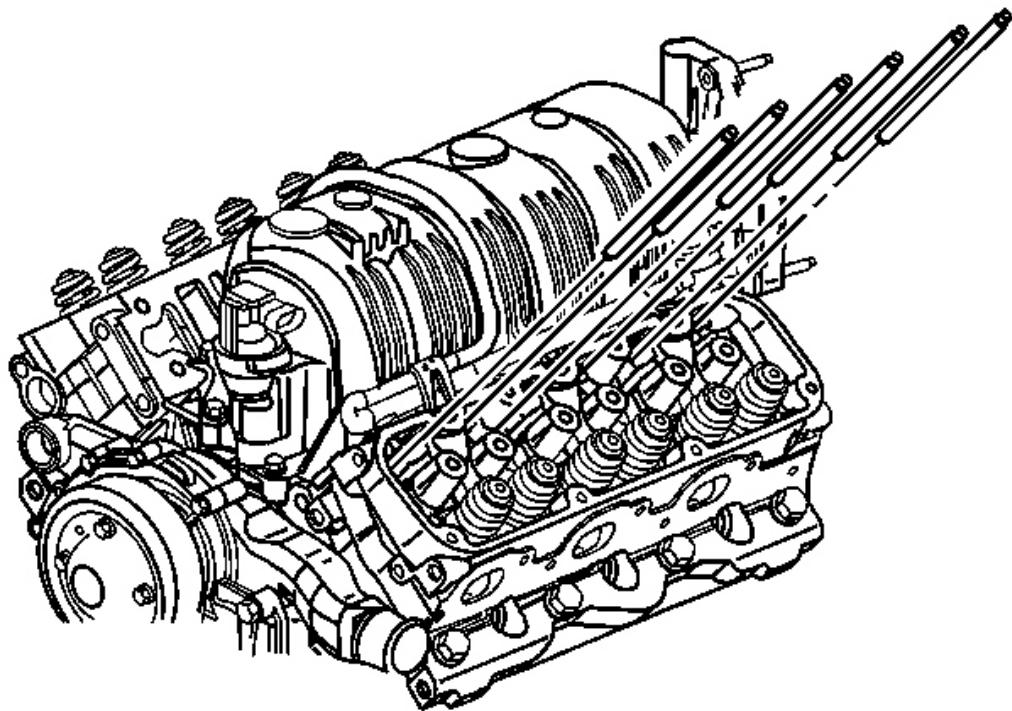
**Fig. 105: View Of Push Rods**

Courtesy of GENERAL MOTORS CORP.

5. Remove the push rod(s).
6. Clean the push rods, the valve rocker arms, the bolts and the guide plates in a suitable solution.
7. Clean the valve rocker arm bolts of all thread adhesive.

**Installation Procedure**

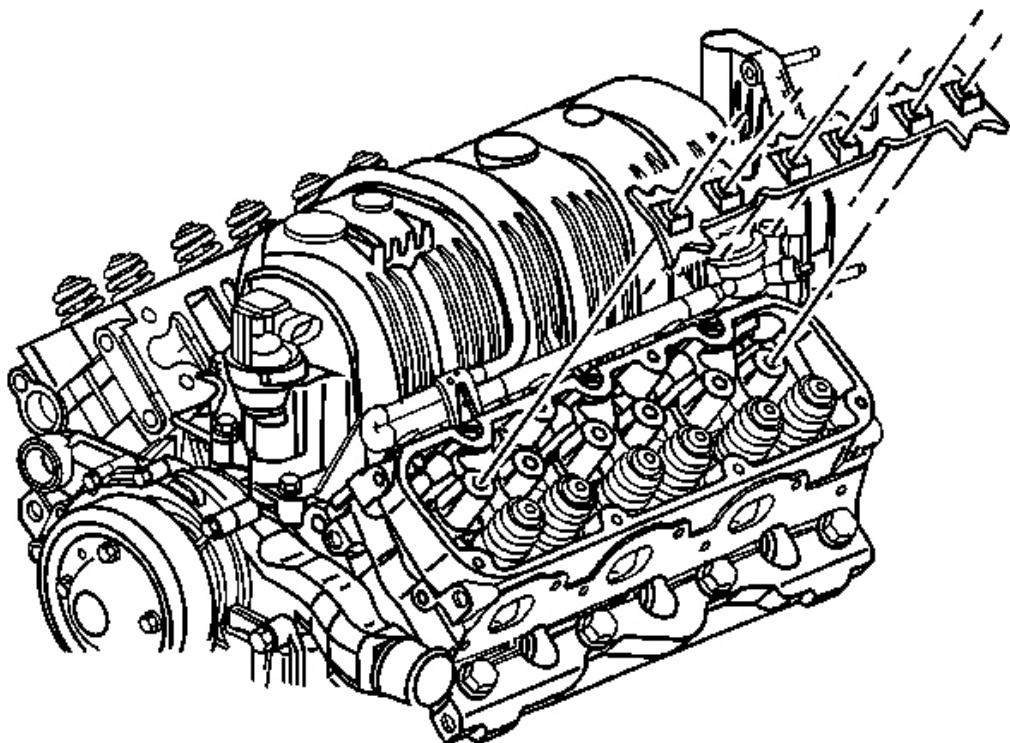
1. Use compressed air in order to blow oil out of the tapped holes in the cylinder head.



**Fig. 106: View Of Push Rods**

Courtesy of GENERAL MOTORS CORP.

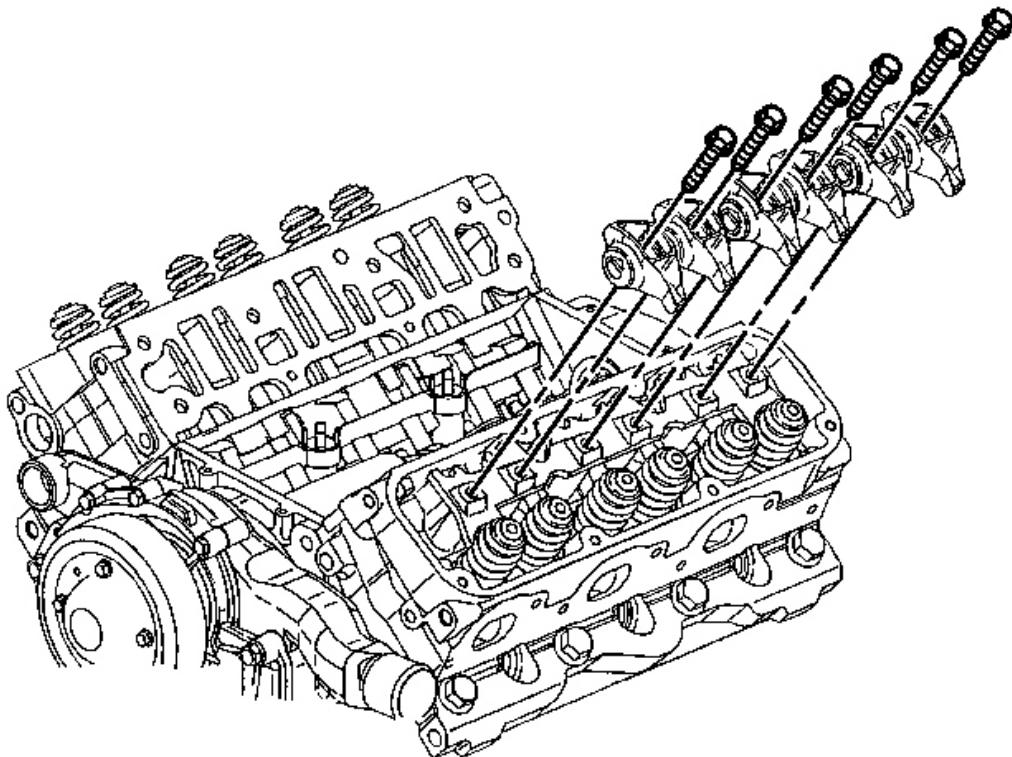
2. Lubricate the ends of the push rods with prelube. Refer to Sealers, Adhesives and Lubricants for the correct part number. Install the push rods to the same position they were removed from.



**Fig. 107: Identifying Push Rod Guide Plates**

Courtesy of GENERAL MOTORS CORP.

3. Install the valve rocker arm guide plate(s).



**Fig. 108: Installing Valve Rocker Arms**  
Courtesy of GENERAL MOTORS CORP.

4. Install the valve rocker arm(s).

**NOTE: Refer to SPECIAL FASTENER NOTICE .**

5. Apply threadlock to the rocker arm bolt threads. Refer to Sealers, Adhesives and Lubricants for the correct part number.

**NOTE: Refer to Fastener Notice .**

6. Install the rocker arm bolt(s).

**Tighten:** Tighten the bolts to 15 N.m (11 lb ft) plus and additional 90 degrees using the **J 45059** . See Special Tools.

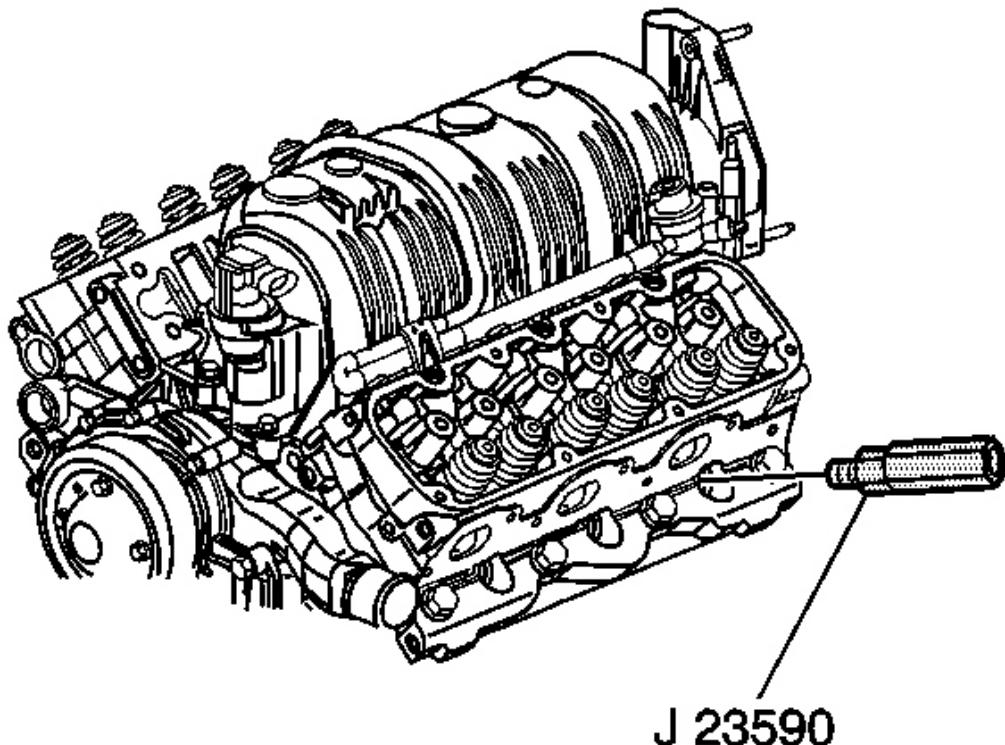
7. Install the valve rocker arm cover(s). Refer to [Valve Rocker Arm Cover Replacement - Left Side](#) and/or [Valve Rocker Arm Cover Replacement - Right Side](#).
8. Inspect the valve train for noise.

## VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT

### Tools Required

- **J 23590** Spark Plug Port Adapter. See [Special Tools](#).
- **J 38606** Valve Spring Compressor
- **J 42863** Valve Stem Seal Installer. See [Special Tools](#).

### Removal Procedure

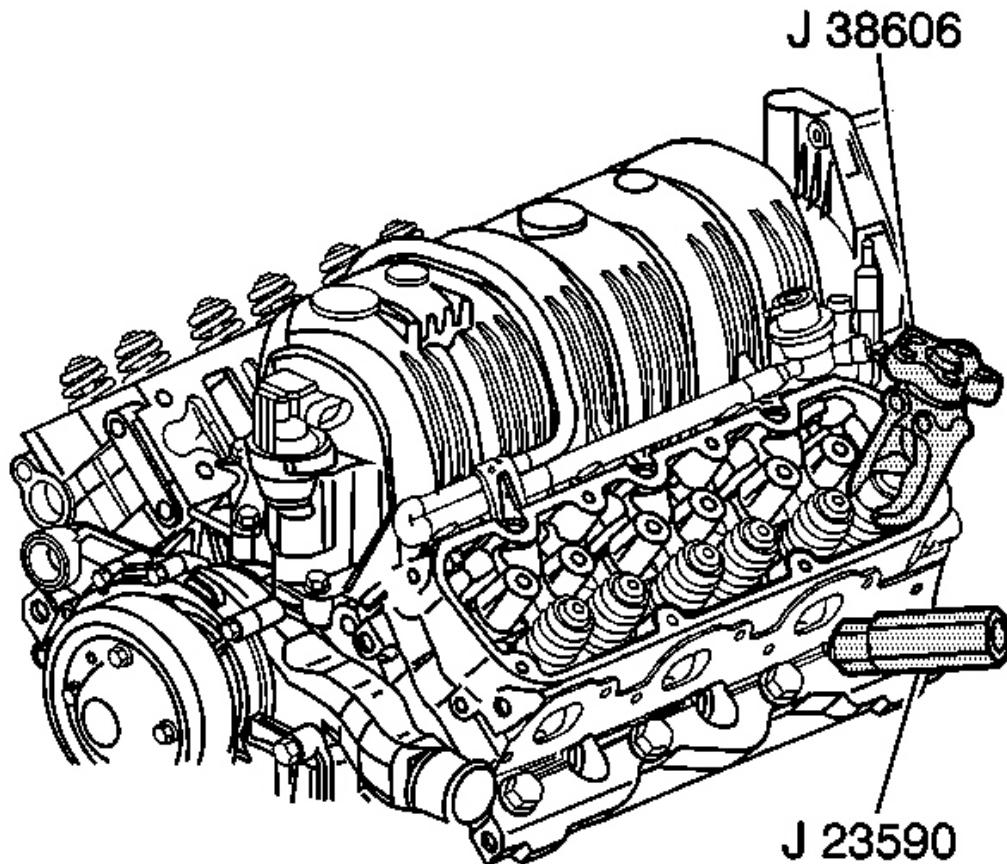


**Fig. 109: Identifying J 23590 At Spark Plug Port**

Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** Rotate the engine so that the piston in the cylinder being worked on is at top dead center before removing the valve locks. This will eliminate the possibility of the valve accidentally falling inside the cylinder.

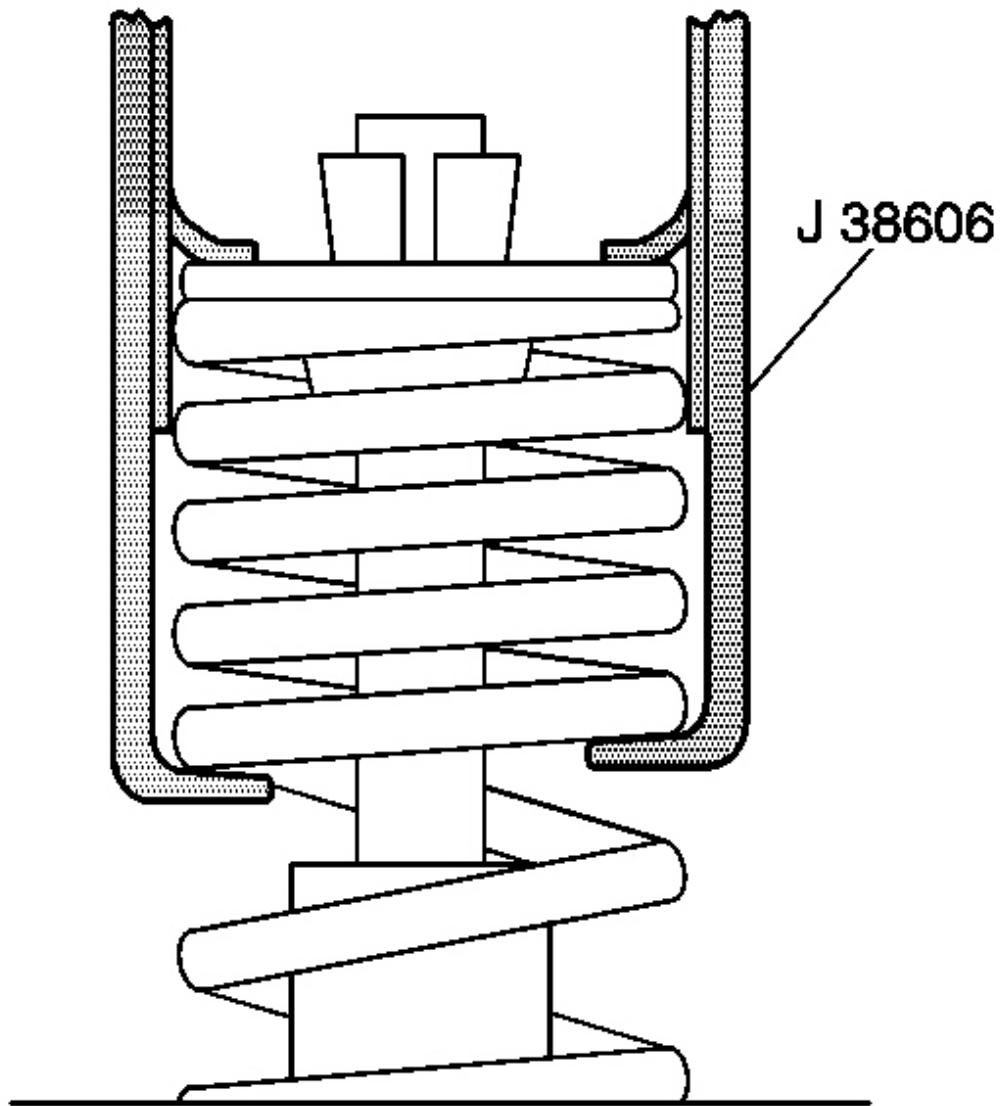
1. Remove the valve rocker arm(s) and push rod(s). Refer to [Valve Rocker Arm and Push Rod Replacement](#).
2. Remove the spark plugs. Refer to [Spark Plug Replacement](#).
3. Install the **J 23590** to the spark plug port and apply compressed air in order to hold the valves closed. See [Special Tools](#).



**Fig. 110: Identifying J 38606 Installed On Valve Spring**

Courtesy of GENERAL MOTORS CORP.

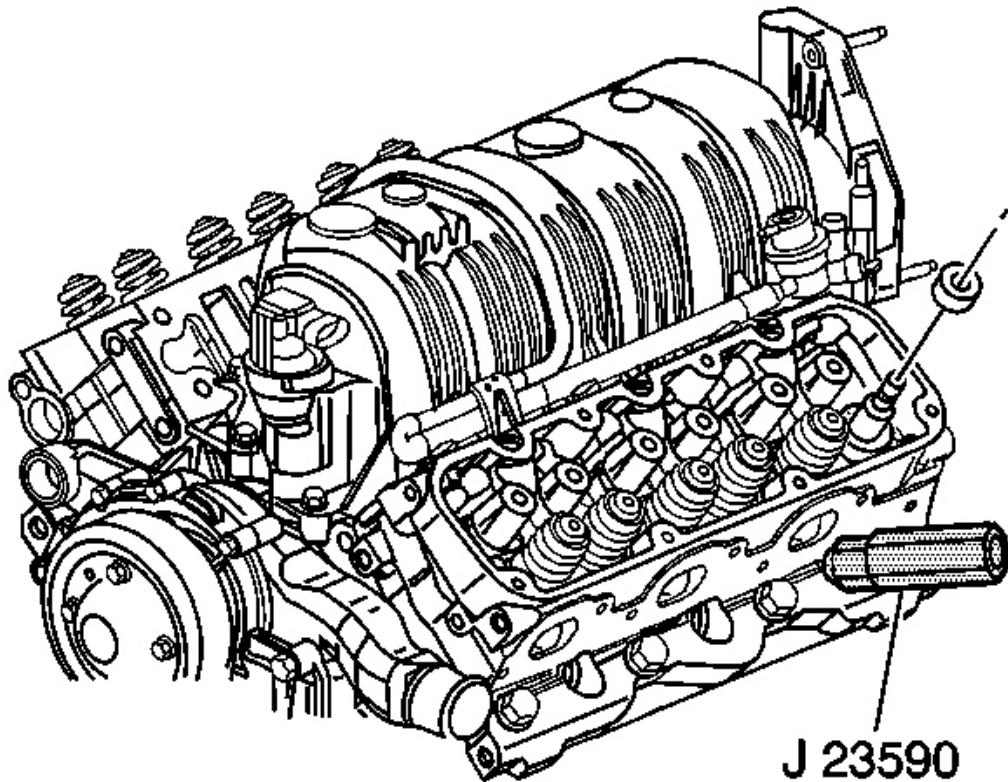
4. Install the **J 38606** on the valve spring.



**Fig. 111: Compressing Valve Spring**  
Courtesy of GENERAL MOTORS CORP.

5. Compress the valve spring using the **J 38606** .
6. Remove the valve locks.

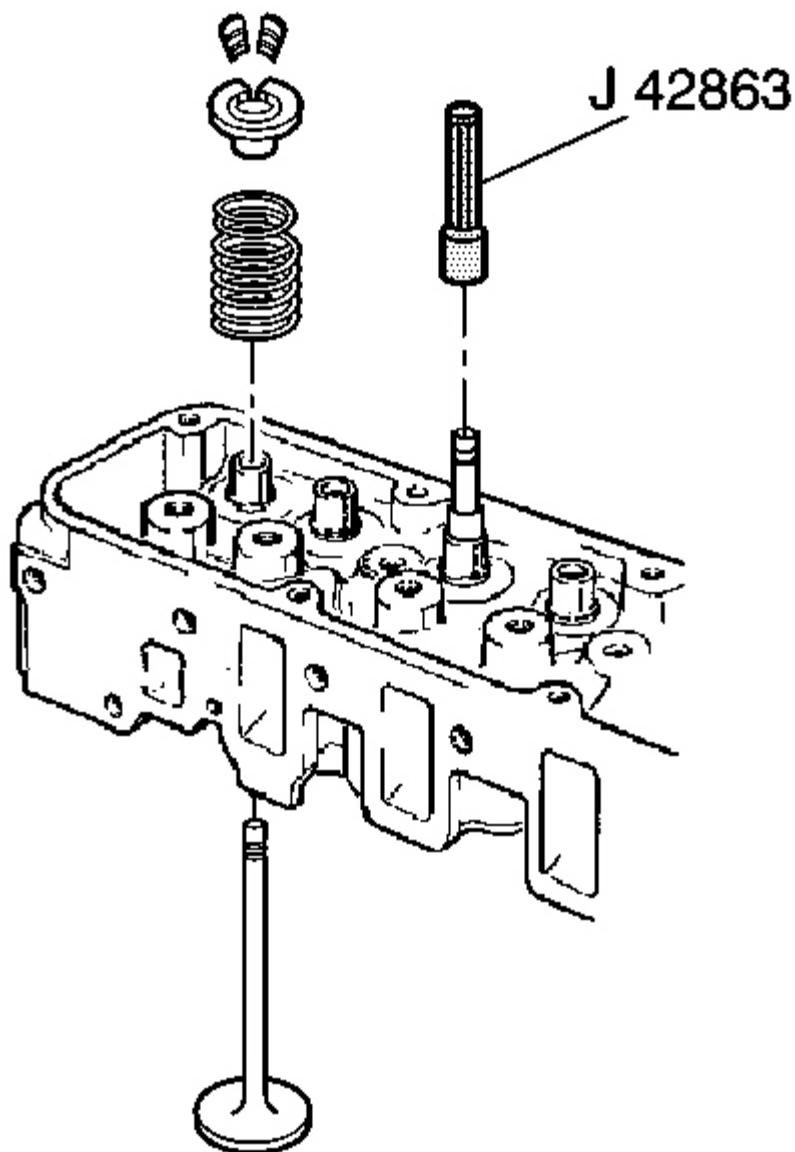
7. Remove the valve spring and cap.



**Fig. 112: Removing Valve Stem Oil Seal**  
Courtesy of GENERAL MOTORS CORP.

8. Remove the valve stem oil seal.

**Installation Procedure**

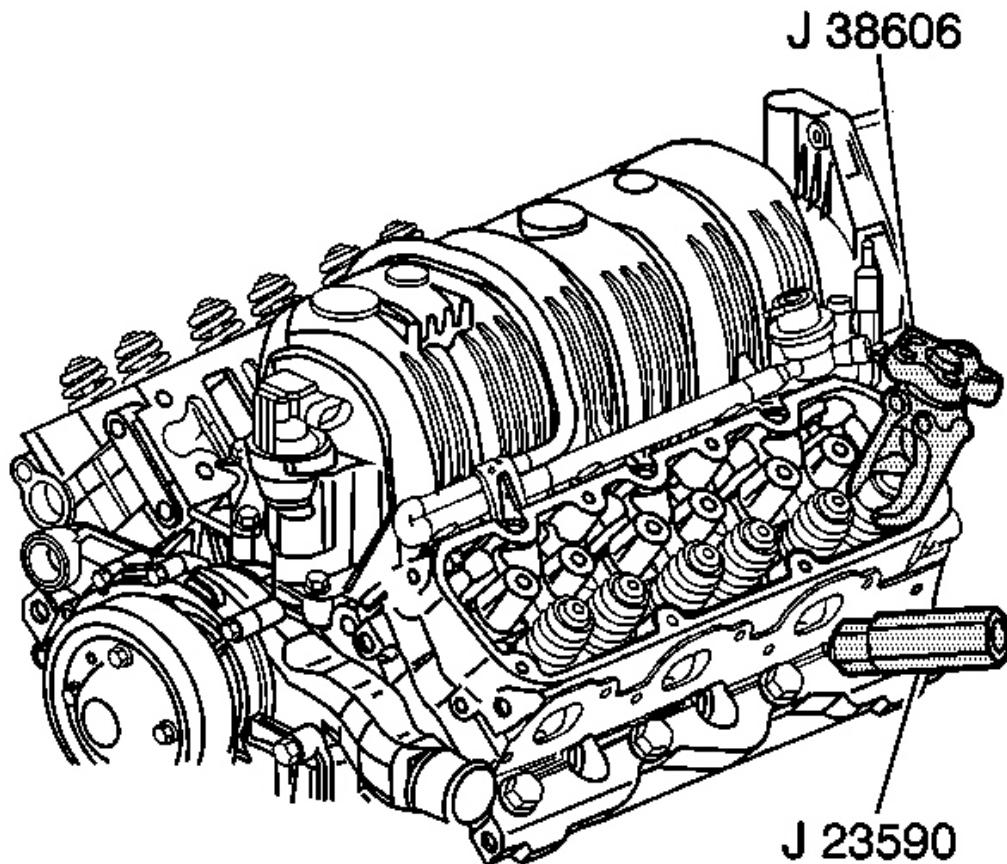


**Fig. 113: Installing Valve Stem Oil Seal**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** • Use hand pressure to install the valve stem oil seal.  
• The color of the replacement seal may not be the same

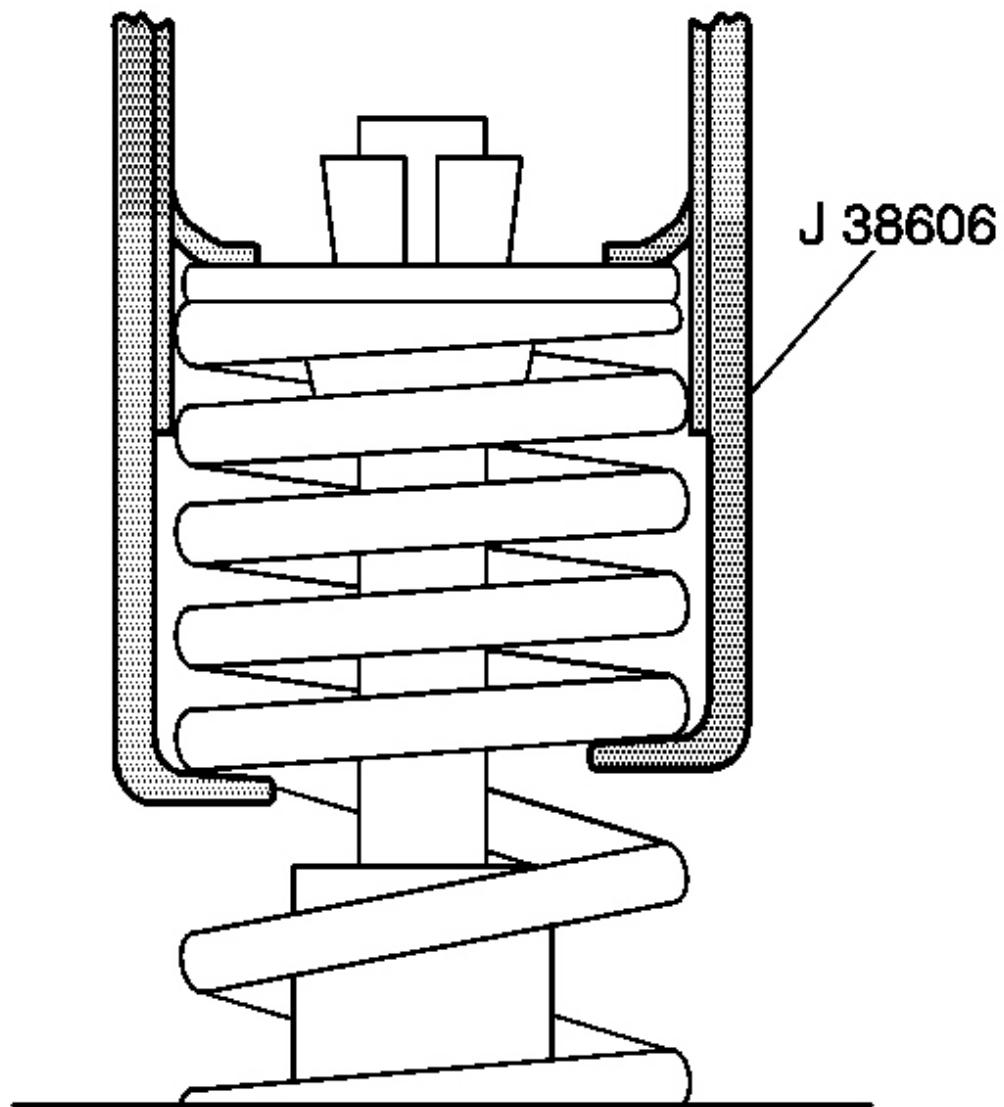
color as the original seal. Install the seals in their correct location based on GM part and package description. Make sure that the seal is fully seated on the valve guide.

1. Place the oil seal over the stem until the seal begins to contact the valve guide.
2. Use the **J 42863** to install the valve stem oil seal over the valve guide. See **Special Tools**.



**Fig. 114: Identifying J 38606 Installed On Valve Spring**  
Courtesy of GENERAL MOTORS CORP.

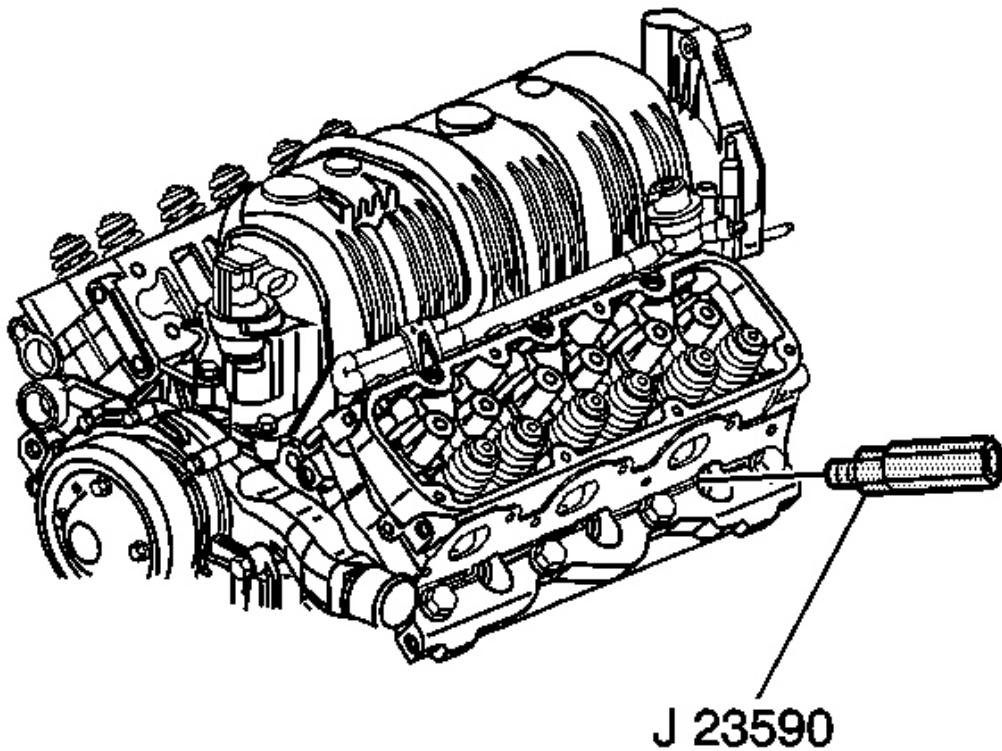
3. Install the **J 38606** on the valve spring.



**Fig. 115: Compressing Valve Spring**  
Courtesy of GENERAL MOTORS CORP.

4. Compress the valve spring using the **J 38606** . See **Special Tools**.
5. Install the valve spring and cap.
6. Install the valve locks.

7. Release the valve spring.



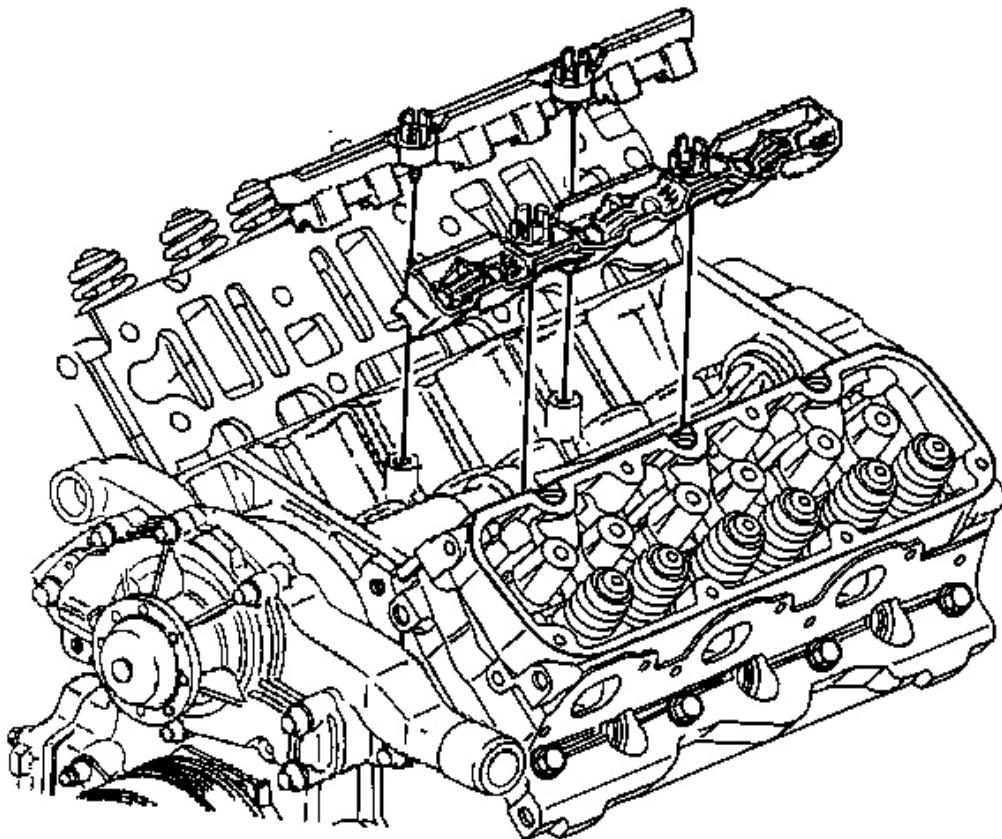
**Fig. 116: Identifying J 23590 At Spark Plug Port**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT: Ensure that the valve locks are seated.**

8. Release the air pressure and remove the **J 23590** . See [Special Tools](#).
9. Install the spark plugs. Refer to [Spark Plug Replacement](#) .
10. Install the push rod(s) and valve rocker arm(s). Refer to [Valve Rocker Arm and Push Rod Replacement](#).

## VALVE LIFTER REPLACEMENT

### Removal Procedure



**Fig. 117: Valve Lifters & Guides**

Courtesy of GENERAL MOTORS CORP.

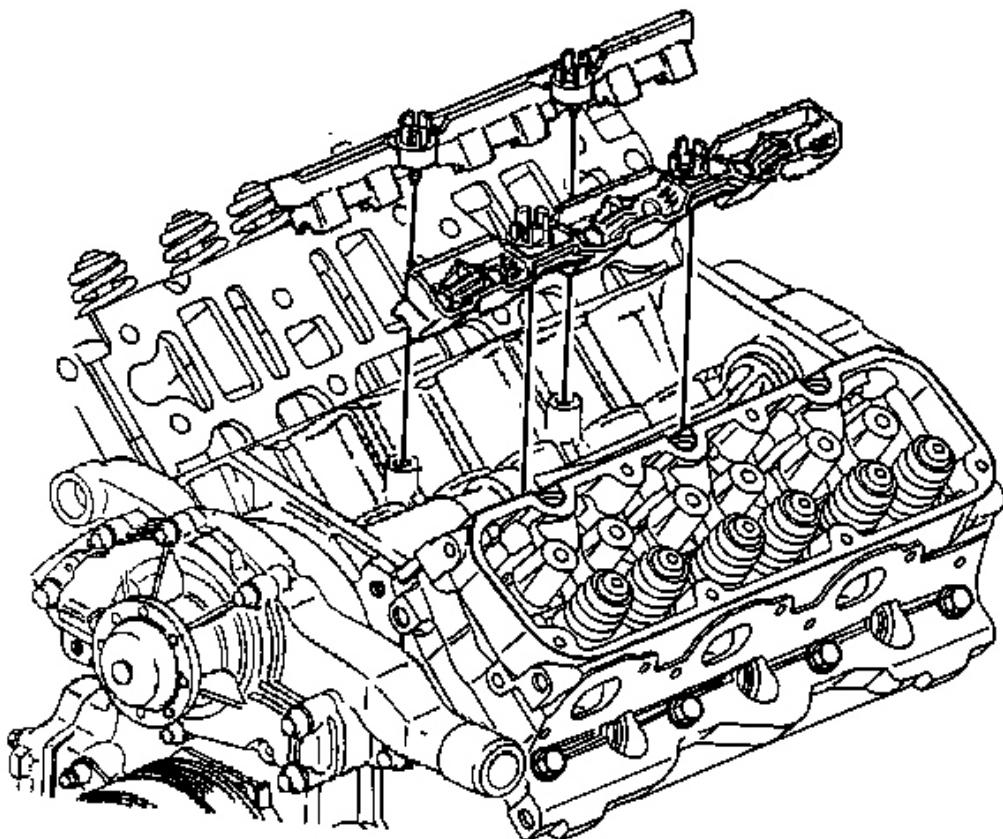
1. Remove the rocker arms and push rods. Refer to [Valve Rocker Arm and Push Rod Replacement](#).
2. Remove the lower intake manifold. Refer to [Lower Intake Manifold Replacement](#).

**IMPORTANT: Ensure that all the valve train parts are kept in order so that they can be reinstalled in their original locations and with the same mating surfaces as when removed.**

3. Remove the valve lifter guide bolts.
4. Remove the valve lifter guides.

5. Remove the valve lifters.
6. Clean all the gasket mating surfaces.
7. Clean the valve train parts.

**Installation Procedure**



**Fig. 118: Valve Lifters & Guides**

Courtesy of GENERAL MOTORS CORP.

1. Dip the valve lifters in prelube. Refer to **Sealers, Adhesives and Lubricants** for the correct part number.
2. Install the valve lifters to the same position the valve lifters were removed.
3. Install the valve lifter guides.

**NOTE: Refer to Fastener Notice .**

4. Install the valve lifter guide bolts.

**Tighten:** Tighten the bolts to 30 N.m (22 lb ft).

5. Install the valve rocker arms and push rods. Refer to Valve Rocker Arm and Push Rod Replacement.
6. Install the lower intake manifold. Refer to Lower Intake Manifold Replacement.

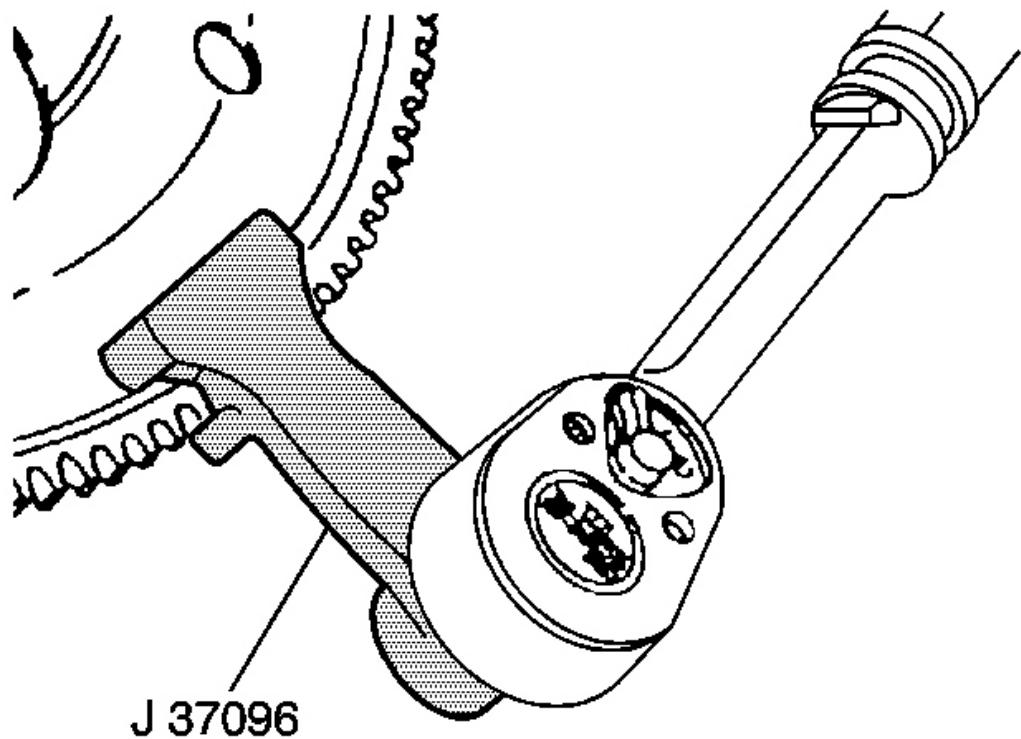
## CRANKSHAFT BALANCER REPLACEMENT

### Tools Required

- **J 37096** Flywheel Holder. See Special Tools.
- **J 38197-A** Crankshaft Balancer Puller. See Special Tools.
- **J 45059** Torque Angle Meter. See Special Tools.

### Removal Procedure

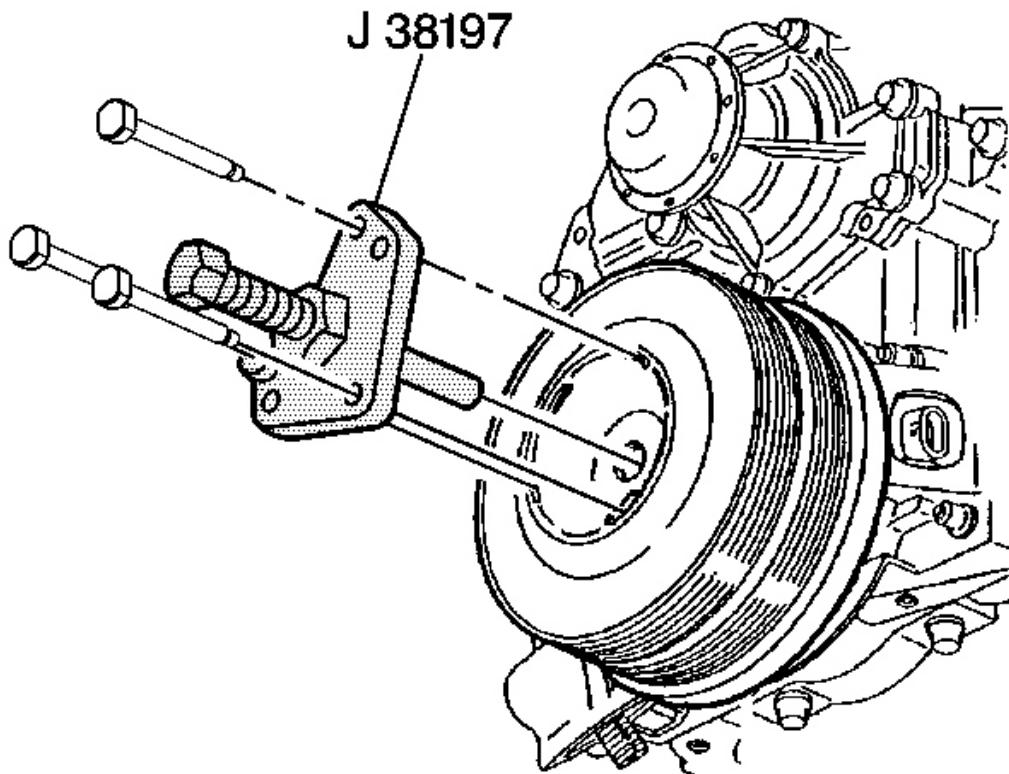
1. Remove the drive belt. Refer to Drive Belt Replacement.
2. Remove the wheel house liner. Refer to Front Wheelhouse Liner Replacement .
3. Remove the torque converter covers. Refer to Torque Converter Cover Replacement .



**Fig. 119: Holding Flywheel**

Courtesy of GENERAL MOTORS CORP.

4. Install the **J 37096** to prevent the flywheel from turning. See [Special Tools](#).
5. Remove the crankshaft balancer bolt and discard the bolt.



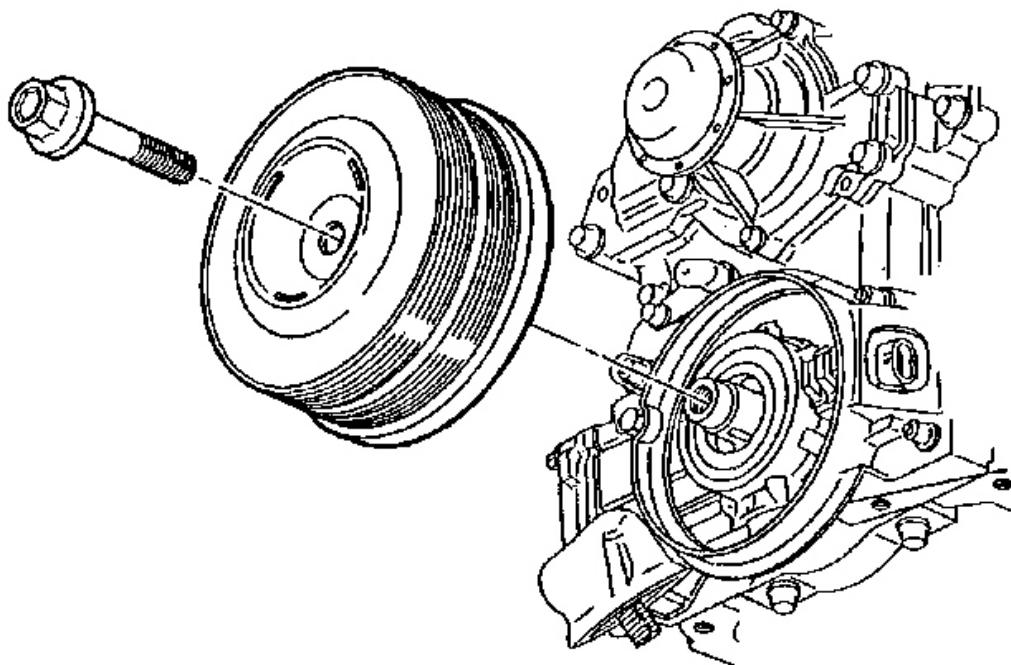
**Fig. 120: Removing Crankshaft Balancer Using J 38197-A**

Courtesy of GENERAL MOTORS CORP.

**IMPORTANT: Do not separate the crankshaft pulley from the crankshaft balancer. Service the crankshaft pulley and the crankshaft balancer as an assembly.**

6. Install the **J 38197-A** . See Special Tools.
7. Remove the crankshaft balancer.
8. Remove the **J 38197-A** . See Special Tools.

Installation Procedure



**Fig. 121: Installing Crankshaft Balancer Using J 37096**  
Courtesy of GENERAL MOTORS CORP.

1. Coat the engine front cover seal contact area on the crankshaft balancer and the seal surface with engine oil.
2. Install the crankshaft balancer.

**NOTE:** Refer to Fastener Notice .

3. Install the new crankshaft balancer bolt. Use the **J 45059** to prevent the flywheel from turning. See Special Tools.

**Tighten:** Tighten the bolt to 150 N.m (111 lb ft) plus an additional 76 degrees using the **J 45059** . See Special Tools.

4. Remove the **J 45059** . See Special Tools.
5. Install the torque converter covers. Refer to Torque Converter Cover Replacement .
6. Install the wheel house liner. Refer to Front Wheelhouse Liner Replacement .

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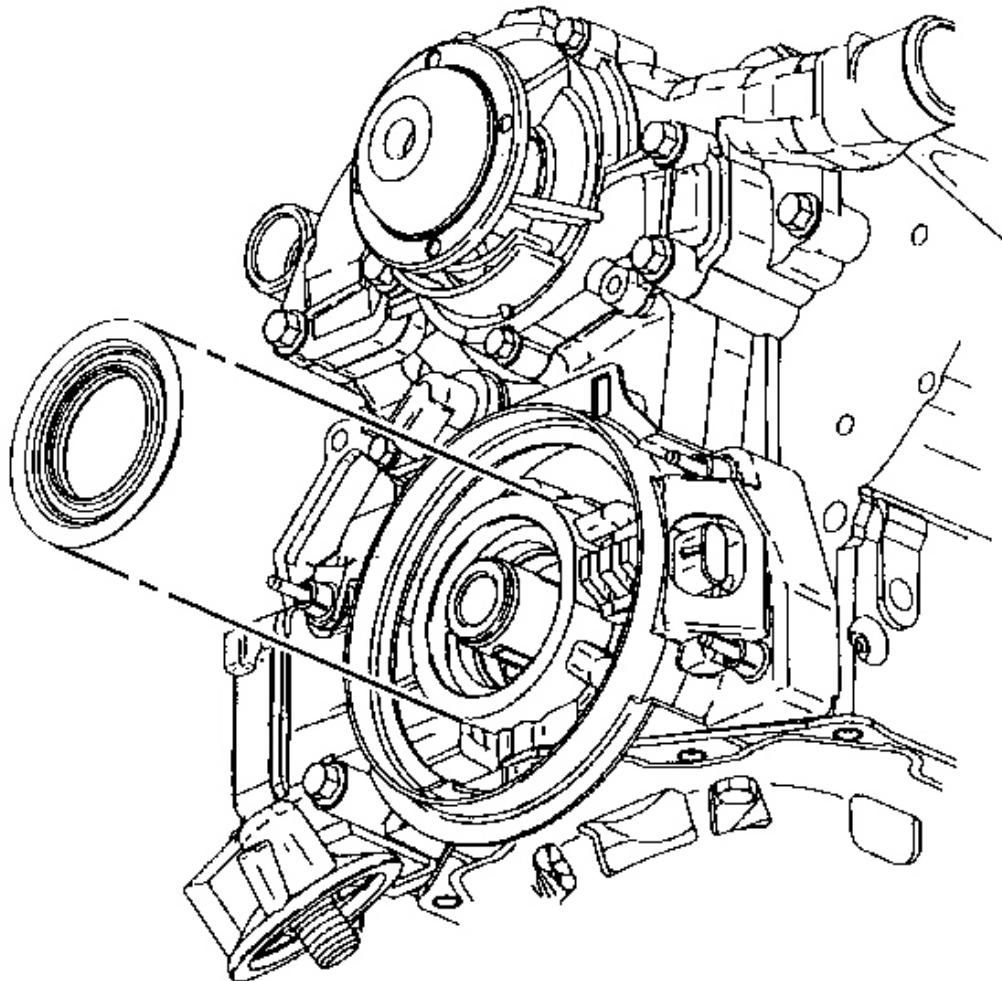
7. Install the drive belt. Refer to [\*\*Drive Belt Replacement\*\*](#).
8. Perform the CKP system variation learn procedure. Refer to [\*\*Crankshaft Position System Variation Learn\*\*](#).

### CRANKSHAFT FRONT OIL SEAL REPLACEMENT

#### Tools Required

**J 35354-A** Seal Installer

#### Removal Procedure

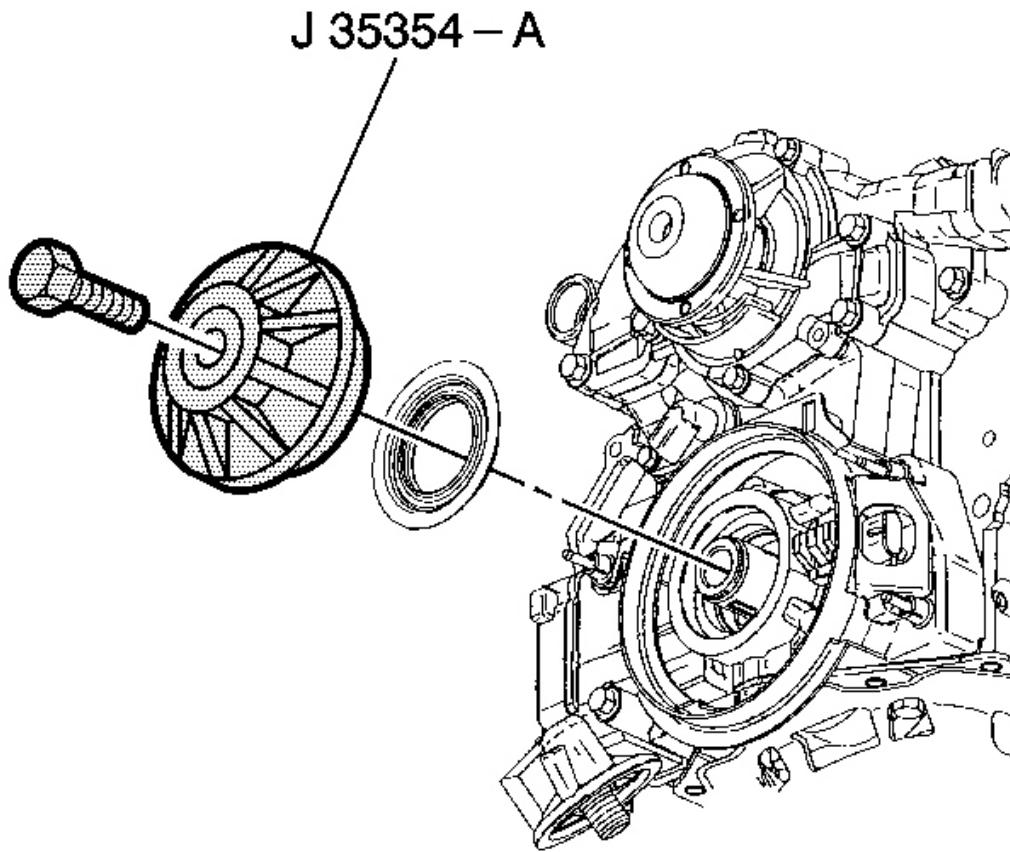


**Fig. 122: Removing Crankshaft Front Oil Seal**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the crankshaft balancer. Refer to [Crankshaft Balancer Replacement](#).

**IMPORTANT: Use care to avoid damaging the crankshaft front oil seal bore or the crankshaft front oil seal contact surfaces.**

2. Pry out the crankshaft front oil seal with a flat-bladed tool such as a large screwdriver.
3. Inspect the crankshaft balancer and engine front cover for scratches.

**Installation Procedure****Fig. 123: Installing Crankshaft Front Oil Seal Using J 35354-A****Courtesy of GENERAL MOTORS CORP.**

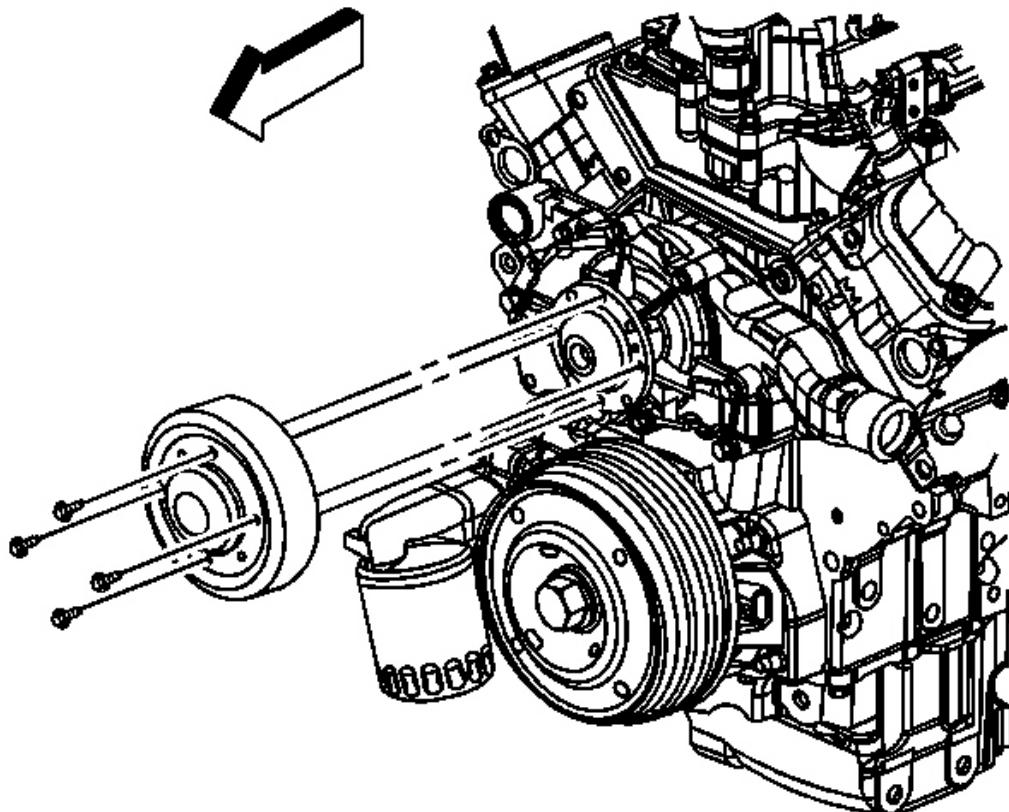
1. Install the crankshaft front oil seal in the engine front cover using the **J 35354-A** .
2. Tighten the bolt until the crankshaft front oil seal is seated in the engine front cover.
3. Remove the **J 35354-A** .
4. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
5. Inspect for leaks.

**ENGINE FRONT COVER REPLACEMENT****Tools Required**

- **J 35354-A** Seal Installer
- **J 38185** Hose Clamp Pliers. See Special Tools.
- **J 45059** Angle Meter. See Special Tools.

#### Removal Procedure

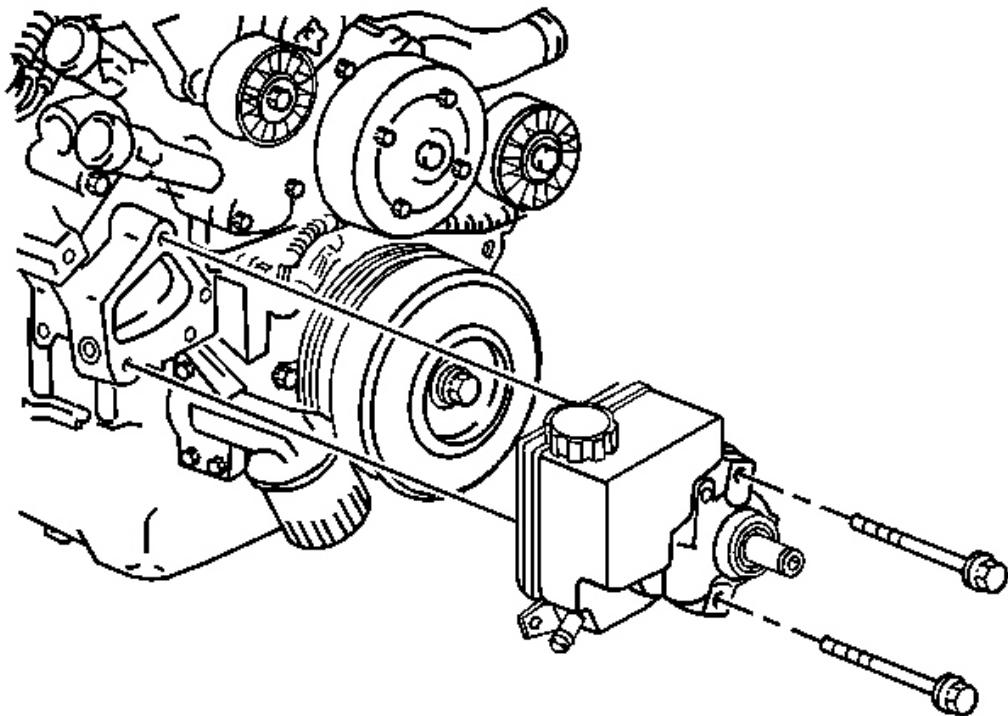
1. Drain the engine oil. Refer to Engine Oil and Oil Filter Replacement.
2. Drain the cooling system. Refer to Cooling System Draining and Filling (Static Fill) or Cooling System Draining and Filling (Vac-N-Fill) .
3. Lower the vehicle.



**Fig. 124: Identifying Water Pump Pulley & Bolts**

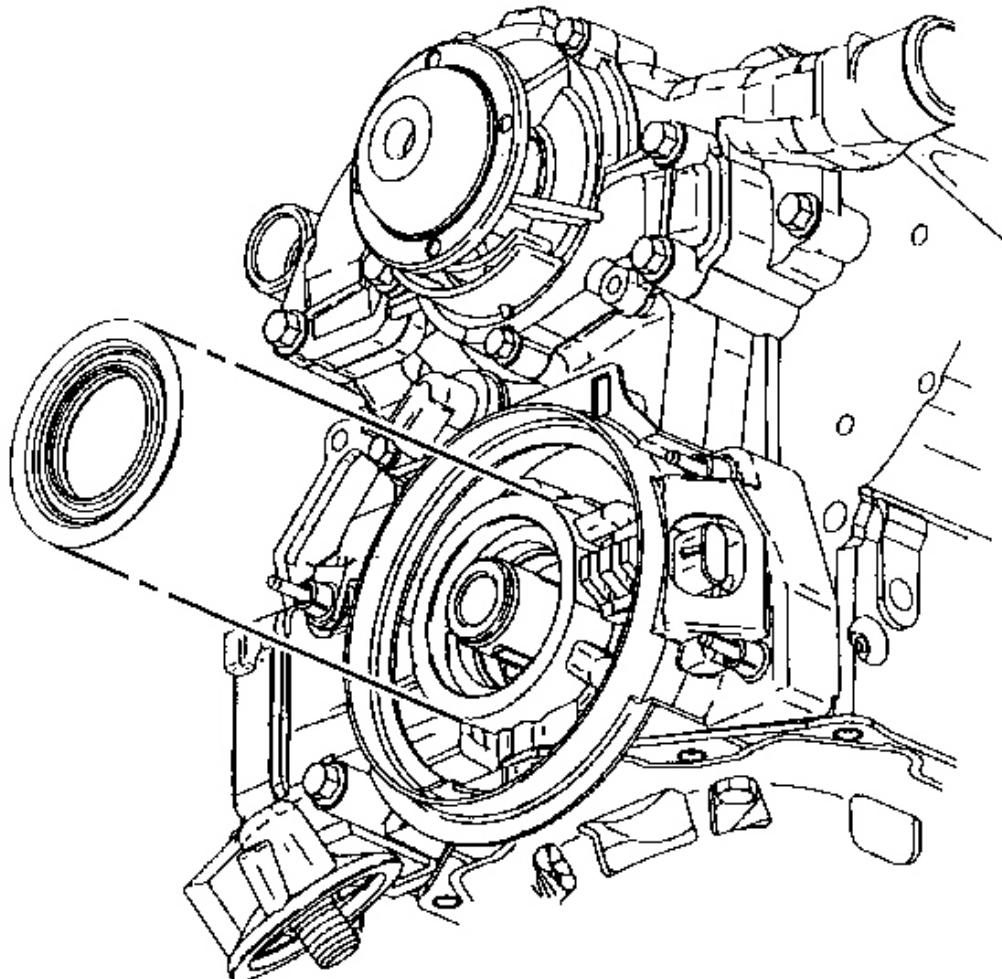
Courtesy of GENERAL MOTORS CORP.

4. Loosen the water pump pulley bolts.
5. Remove the drive belt tensioner. Refer to [\*\*Drive Belt Tensioner Replacement\*\*](#).
6. Remove the water pump pulley.



**Fig. 125: View Of Power Steering Pump And Mounting Bolts**  
Courtesy of GENERAL MOTORS CORP.

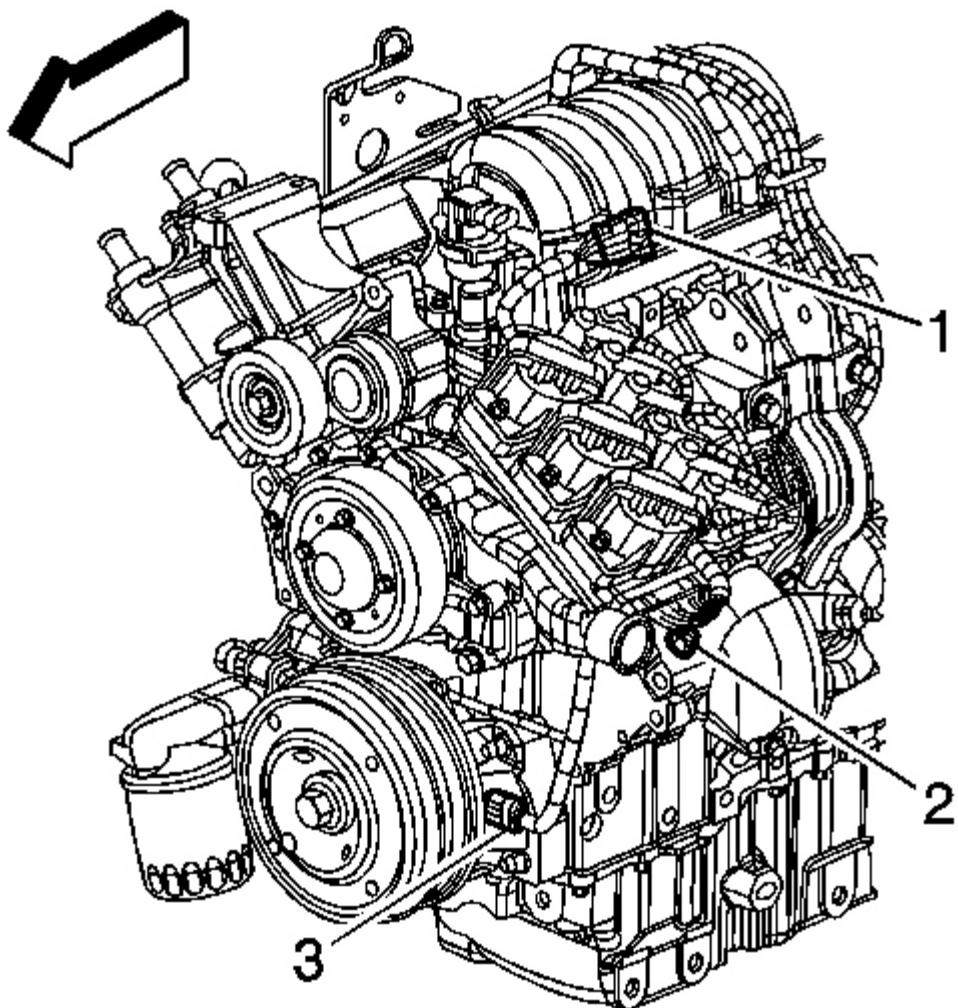
7. Remove the power steering pump bolts and reposition the pump.
8. Raise and support the vehicle. Refer to [\*\*Lifting and Jacking the Vehicle\*\*](#).
9. Remove the crankshaft balancer. Refer to [\*\*Crankshaft Balancer Replacement\*\*](#).



**Fig. 126: Removing Crankshaft Front Oil Seal**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT: Be careful not to damage the crankshaft.**

10. Pry out the crankshaft front oil seal with a flat-bladed tool. Use care to avoid damaging the crankshaft front oil seal bore or the crankshaft front oil seal contact surfaces.

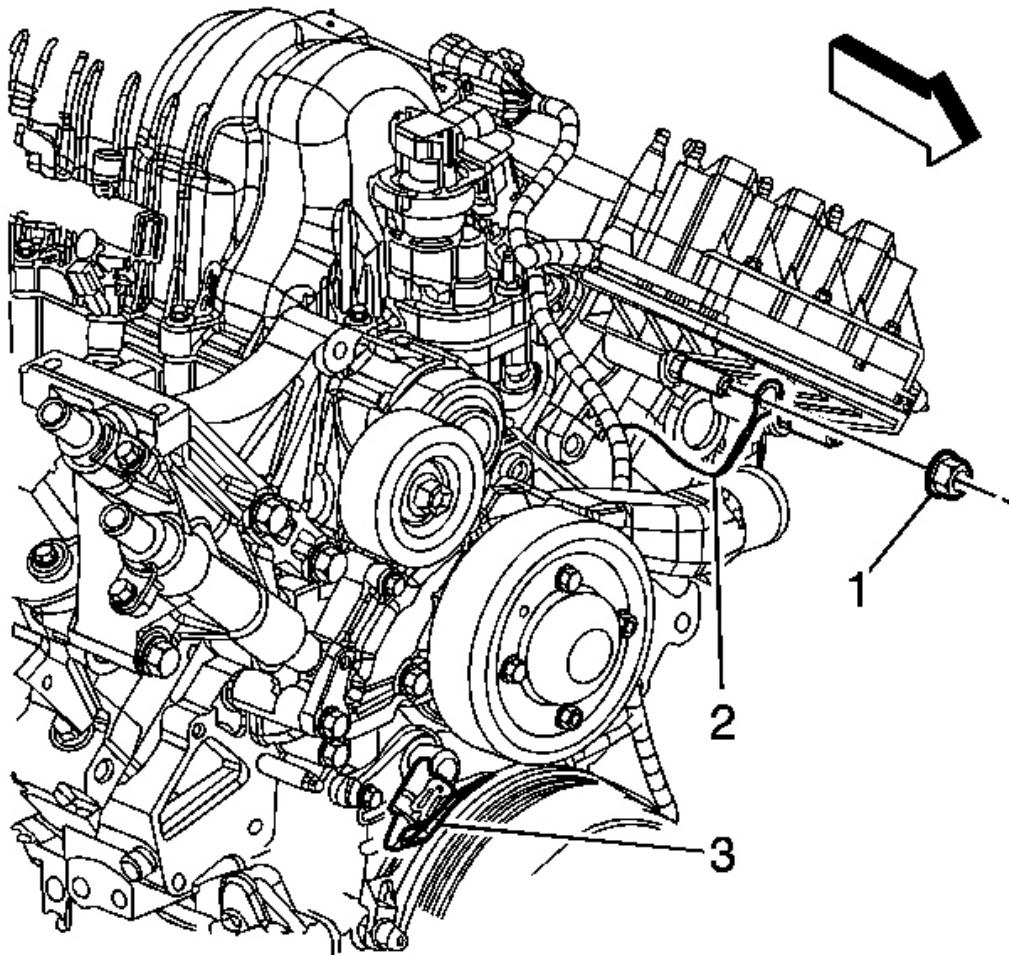


**Fig. 127: Identifying Ignition Control Module Wiring Harness Electrical Connector**  
Courtesy of GENERAL MOTORS CORP.

11. Disconnect the ignition control module wiring harness electrical connector (3) from the crankshaft position (CKP) sensor.

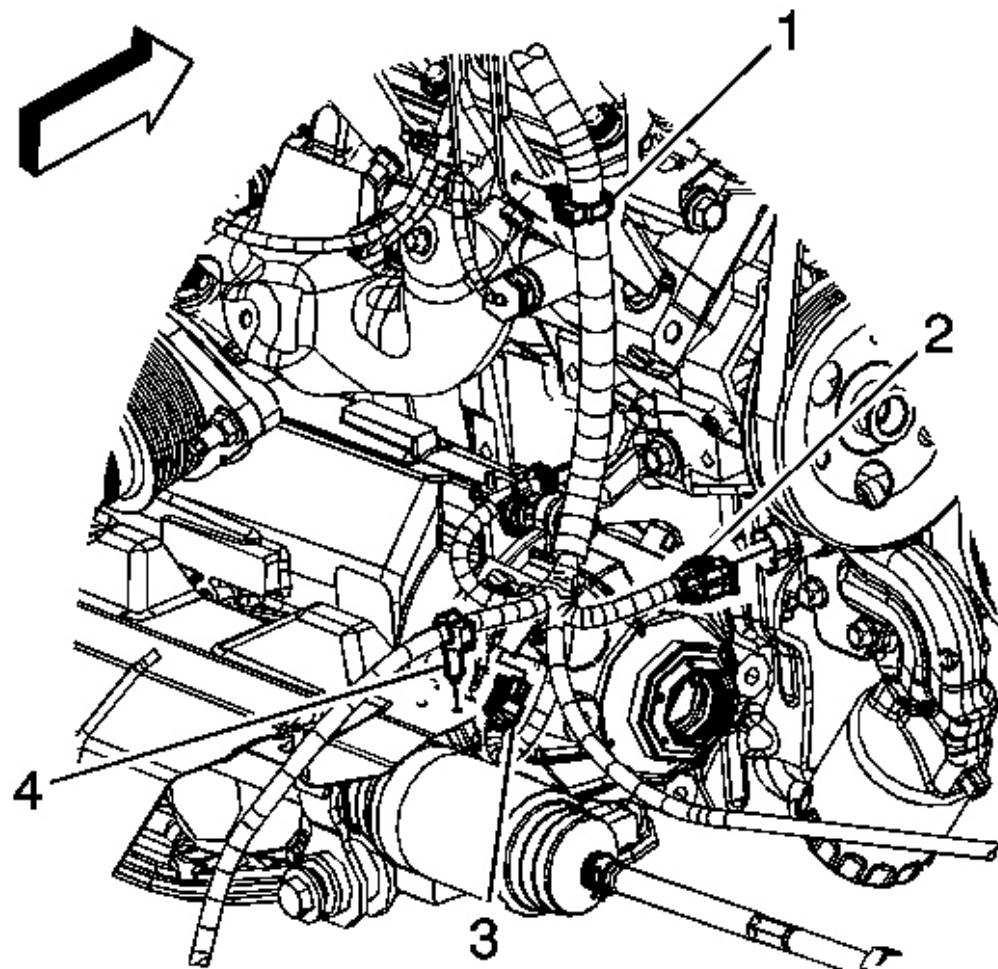
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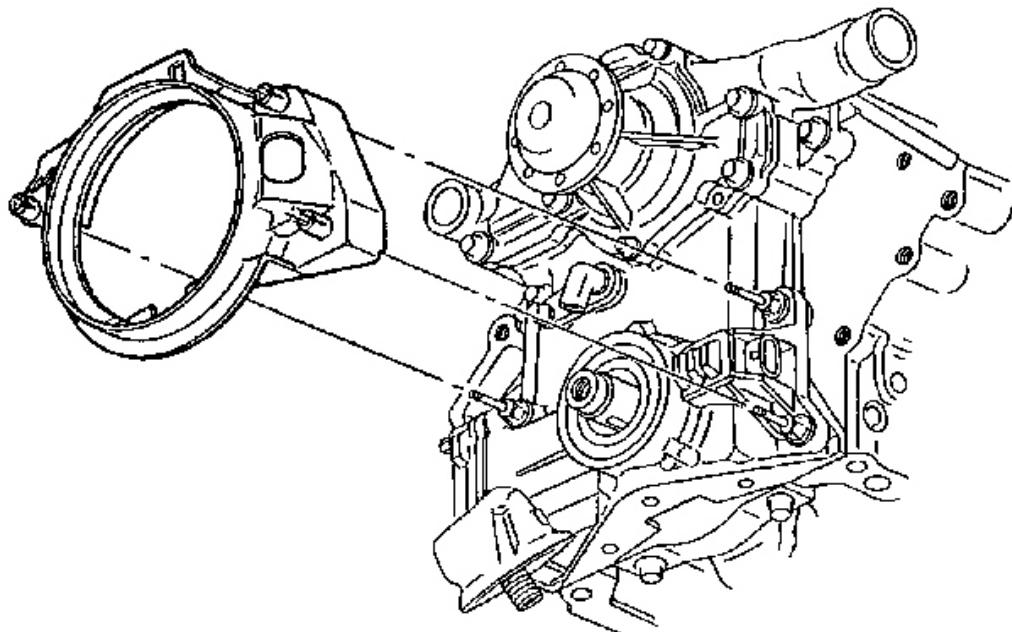
**Fig. 128: Identifying Camshaft Position (CMP) Sensor Connector**  
Courtesy of GENERAL MOTORS CORP.

12. Disconnect the ignition control module wiring harness electrical connector (3) from the camshaft position (CMP) sensor.



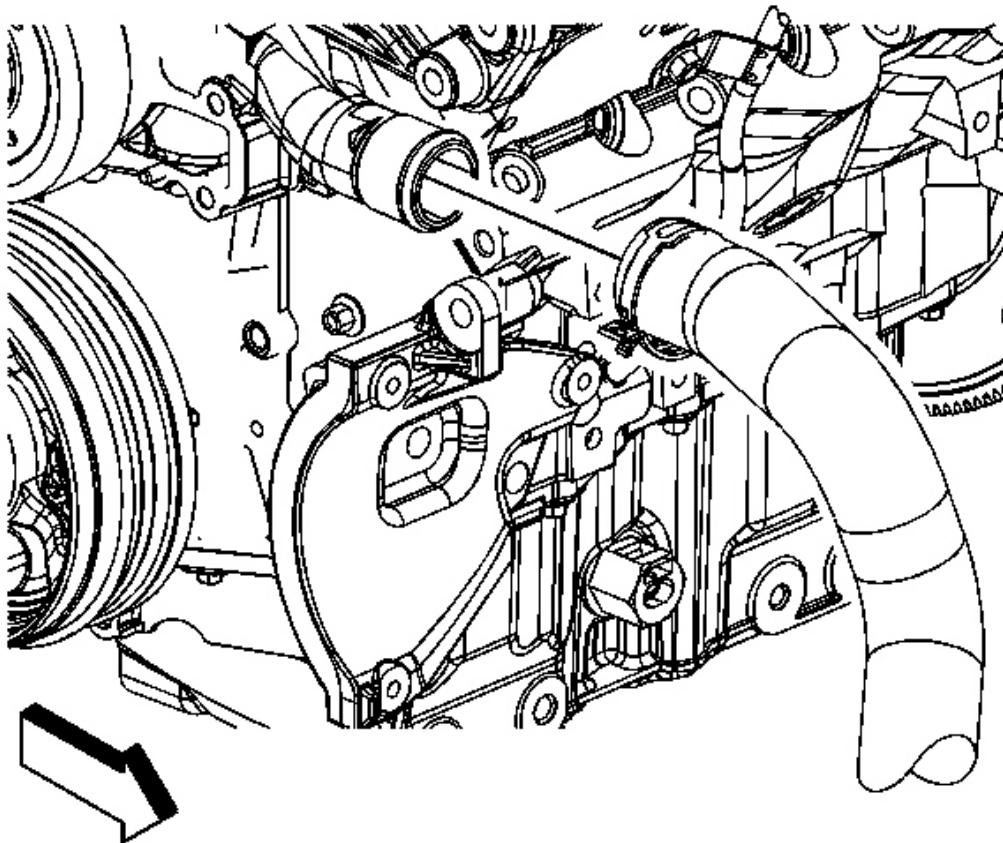
**Fig. 129: Identifying Oil Pressure Sensor Connector**  
Courtesy of GENERAL MOTORS CORP.

13. Disconnect the engine harness electrical connector (2) from the oil pressure sensor.



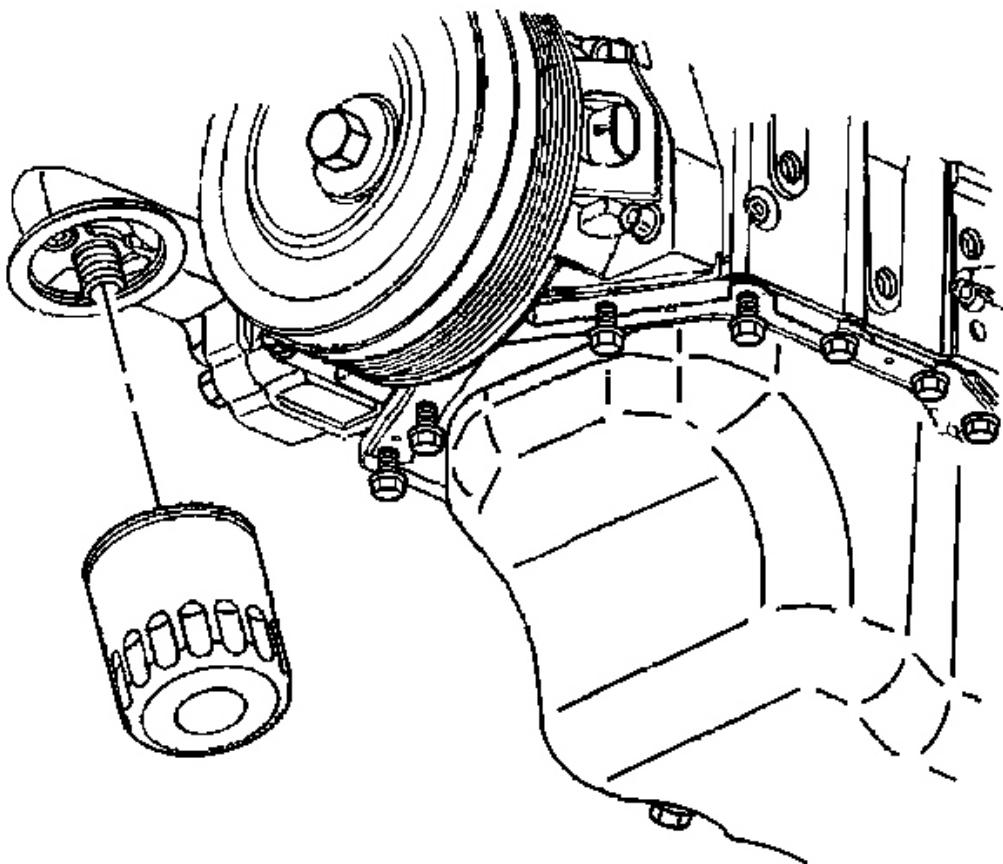
**Fig. 130: Identifying Crankshaft Position Sensor Shield**  
Courtesy of GENERAL MOTORS CORP.

14. Remove the CKP sensor shield.



**Fig. 131: View Of Radiator Outlet Hose**  
Courtesy of GENERAL MOTORS CORP.

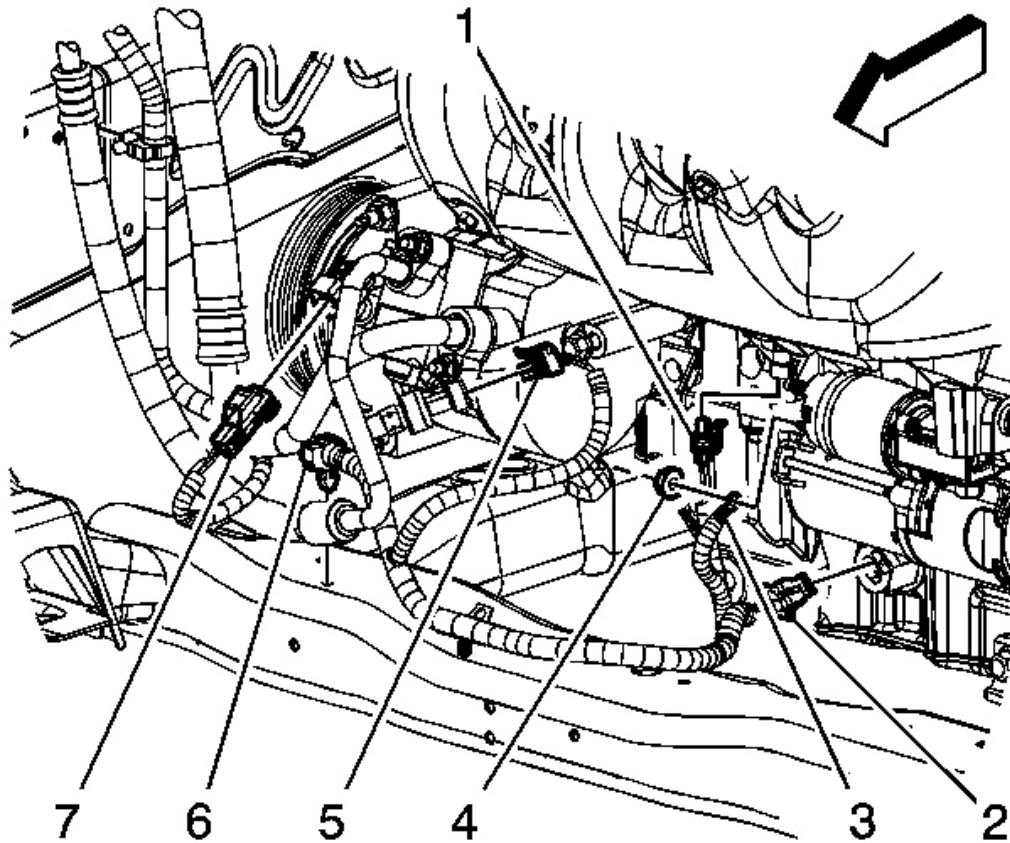
15. Using the **J 38185** reposition the radiator outlet hose clamp. See **Special Tools**.
16. Remove the radiator outlet hose from the engine front cover.
17. Lower the vehicle.
18. Install the engine support fixture. Refer to **Engine Support Fixture**.
19. Raise the vehicle.



**Fig. 132: Identifying Oil Filter**

Courtesy of GENERAL MOTORS CORP.

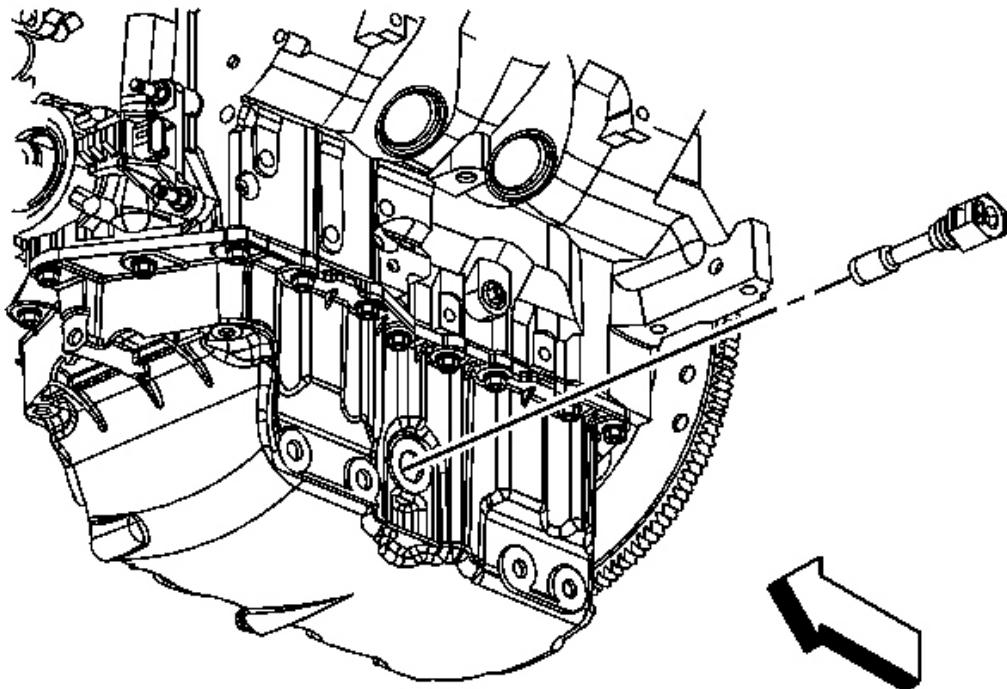
20. Remove the oil filter.
21. Remove the engine mount bracket. Refer to [Engine Front Mount Bracket Replacement](#).



**Fig. 133: Identifying Stater & Cable Components**

Courtesy of GENERAL MOTORS CORP.

22. Disconnect the engine harness electrical connector (2) from the oil level sensor.



**Fig. 134: Identifying Oil Level Sensor**

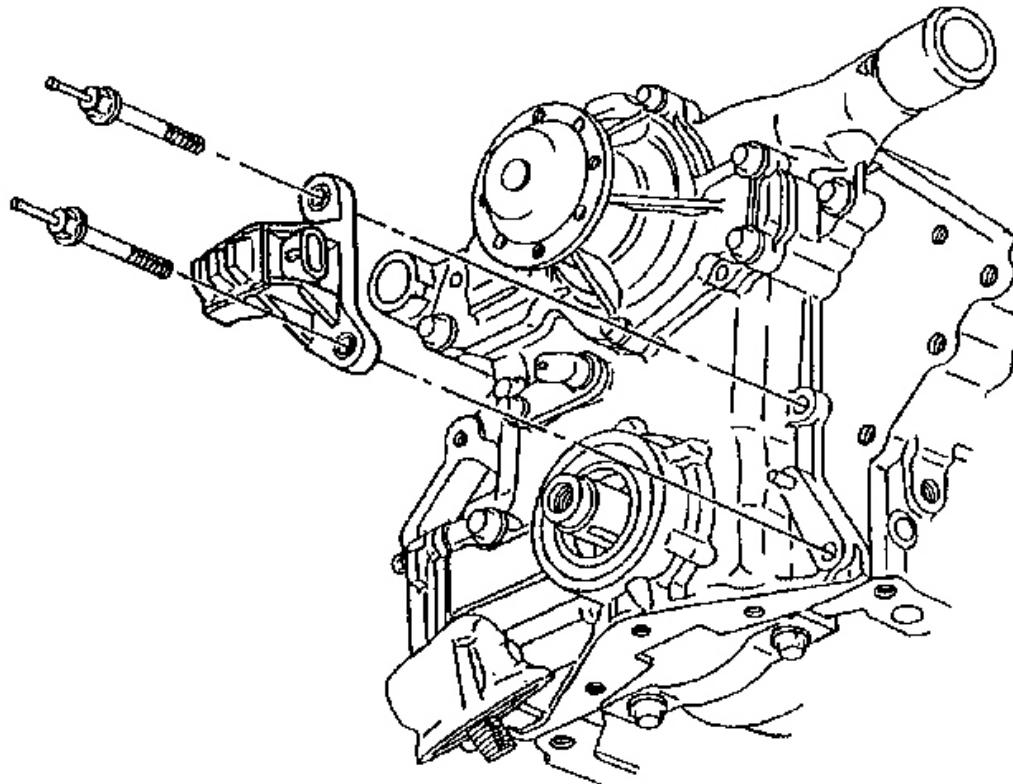
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT: The oil pan can be dropped slightly for engine front cover clearance if all pan bolts are loosened and the oil level sensor is removed.**

23. Remove the oil level sensor.
24. Remove the oil pan-to-engine front cover bolts.
25. Remove the oil pan. Refer to **Oil Pan Replacement**.

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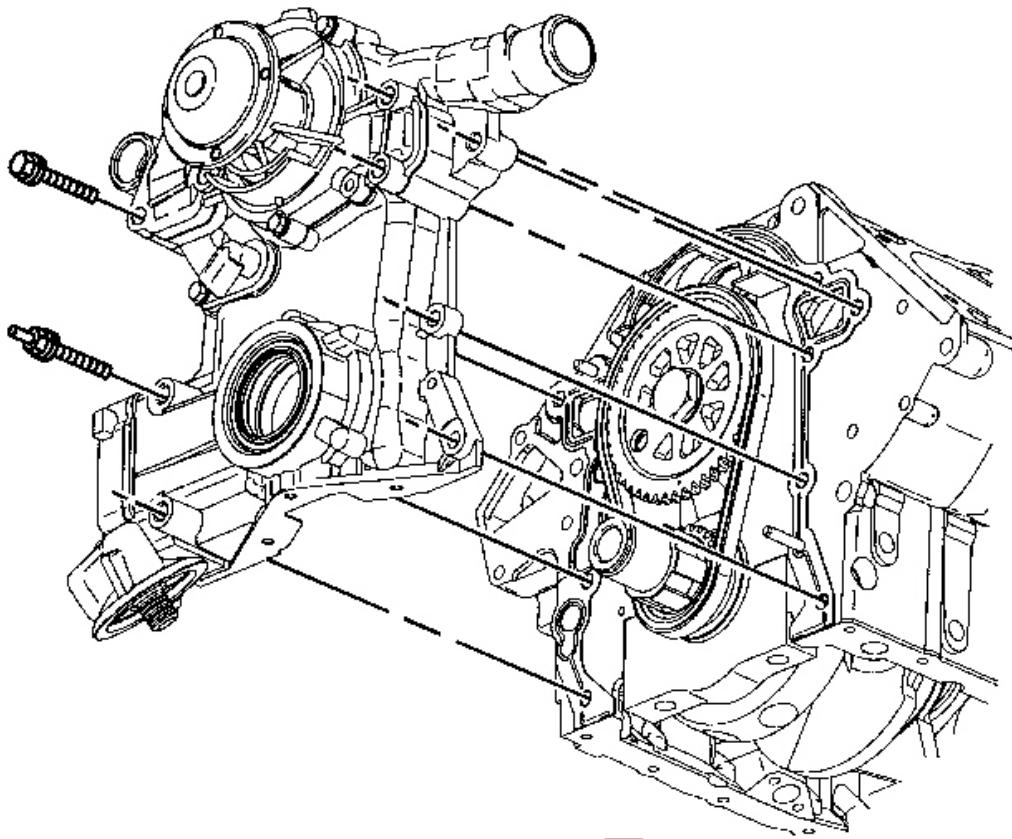


**Fig. 135: Identifying Crankshaft Position Sensor**  
Courtesy of GENERAL MOTORS CORP.

26. Remove the CKP sensor studs and sensor.

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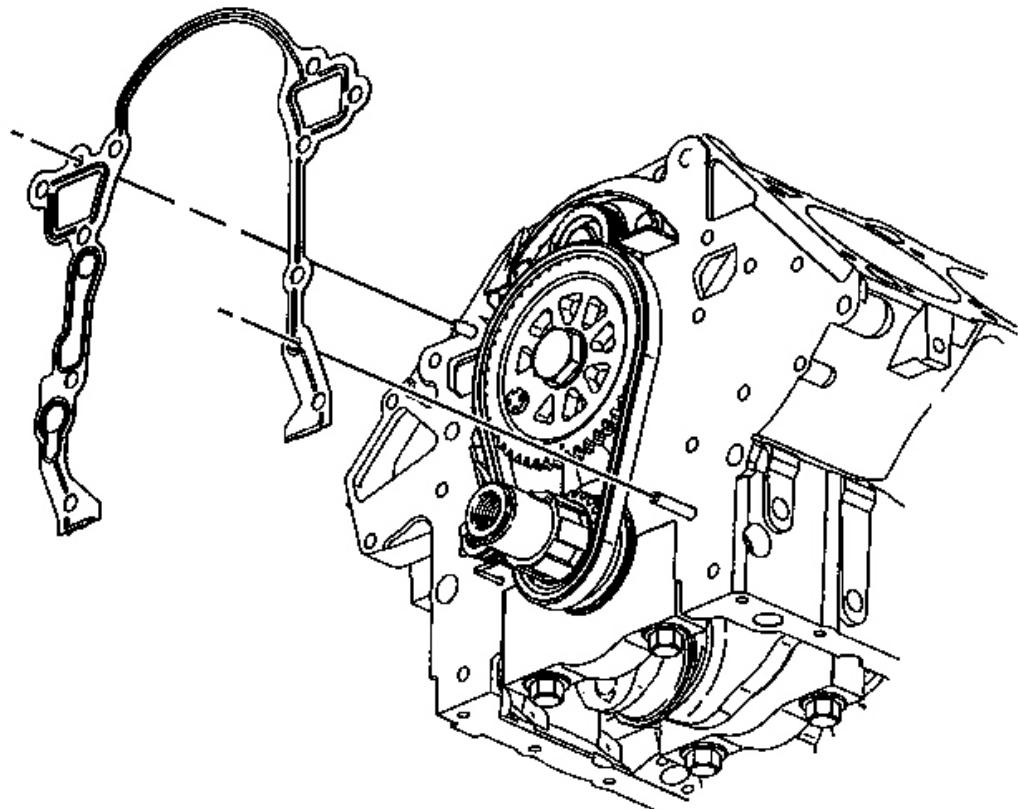


**Fig. 136: View Of Engine Front Cover & Oil Filter Adapter**  
Courtesy of GENERAL MOTORS CORP.

27. Remove the engine front cover bolts/stud.
28. Remove the engine front cover.

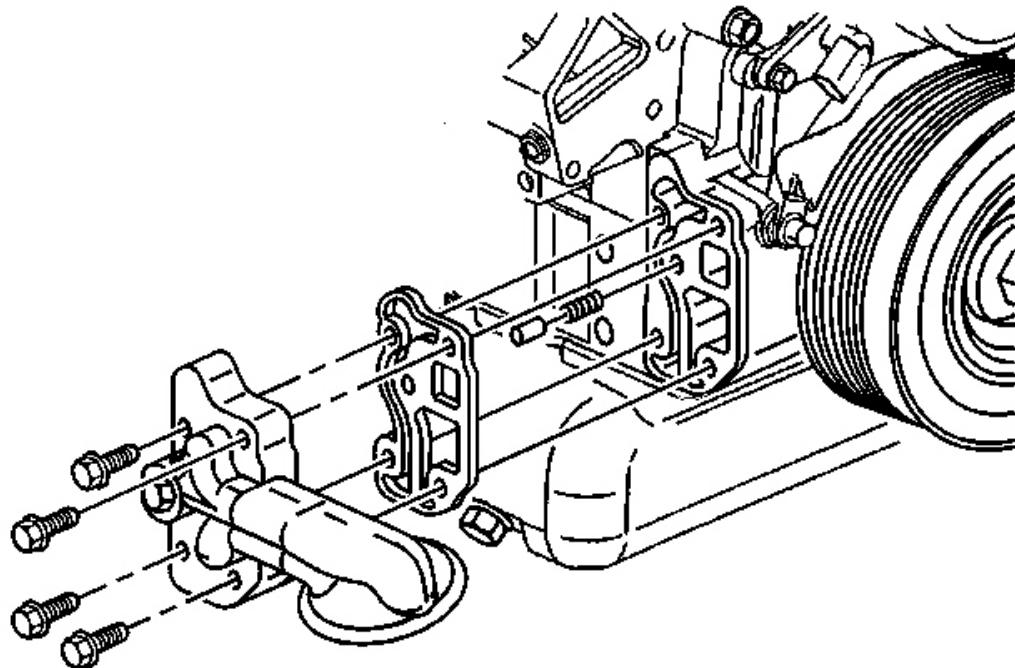
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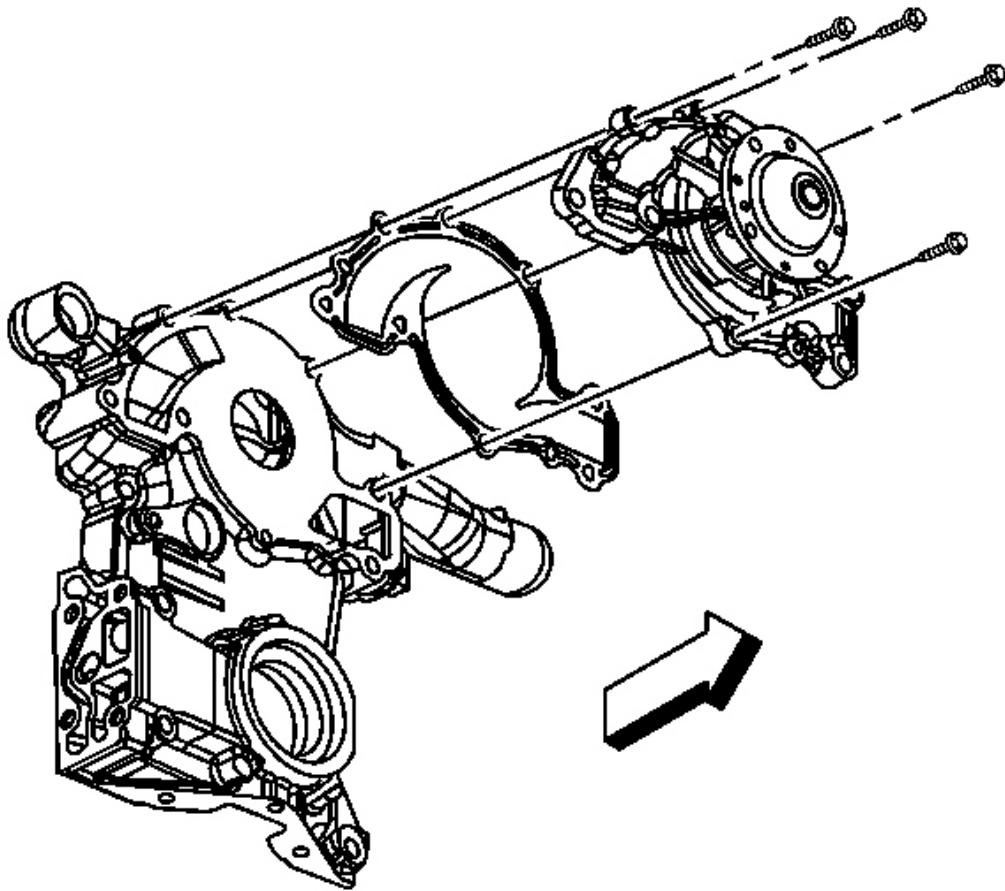
**Fig. 137: Identifying Engine Front Cover Gasket**  
Courtesy of GENERAL MOTORS CORP.

29. Remove the engine front cover gasket.



**Fig. 138: Removing/Installing Oil Filter Adapter & Pressure Relief Valve**  
Courtesy of GENERAL MOTORS CORP.

30. If replacing the engine front cover, perform the following steps, otherwise proceed to step 14 in the installation procedure.
31. Remove the oil filter adapter bolts.
32. Remove the oil filter adapter and gasket.
33. Remove the oil pressure relief valve and spring.

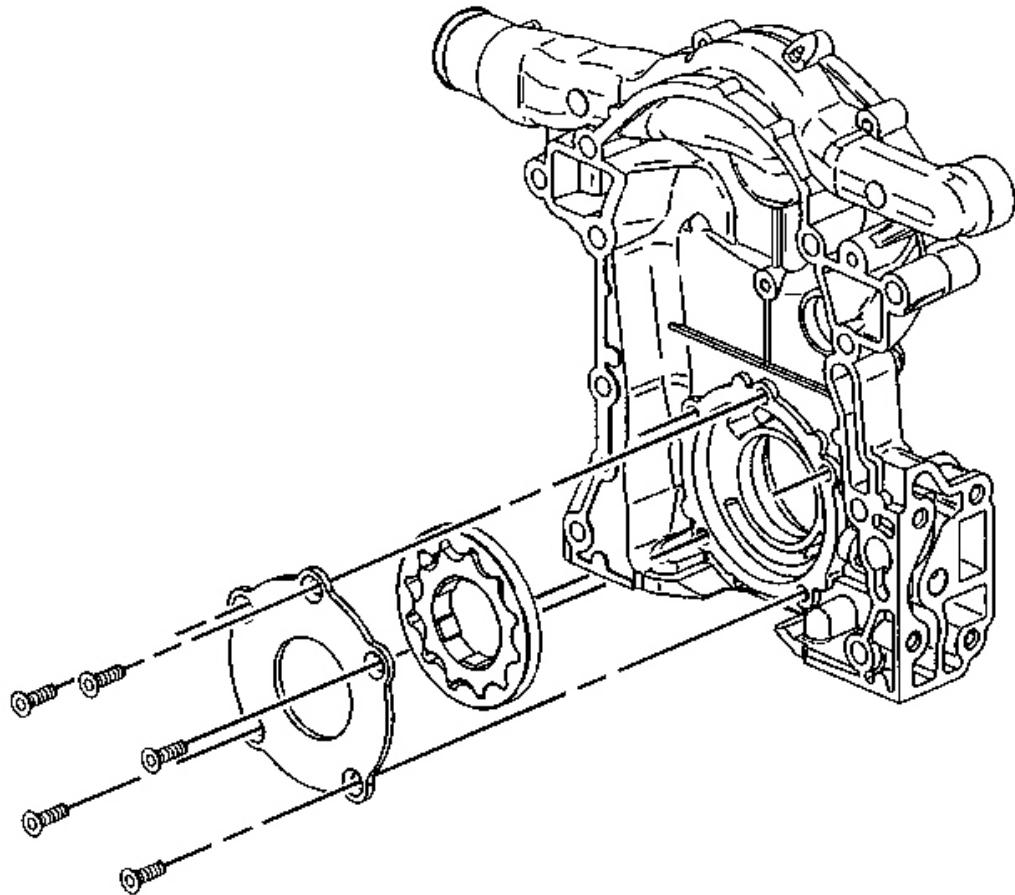


**Fig. 139: Water Pump Assembly**  
Courtesy of GENERAL MOTORS CORP.

34. Remove the water pump bolts.
35. Remove the water pump and gasket.
36. Remove the oil pump cover screws.
37. Remove the oil pump cover.

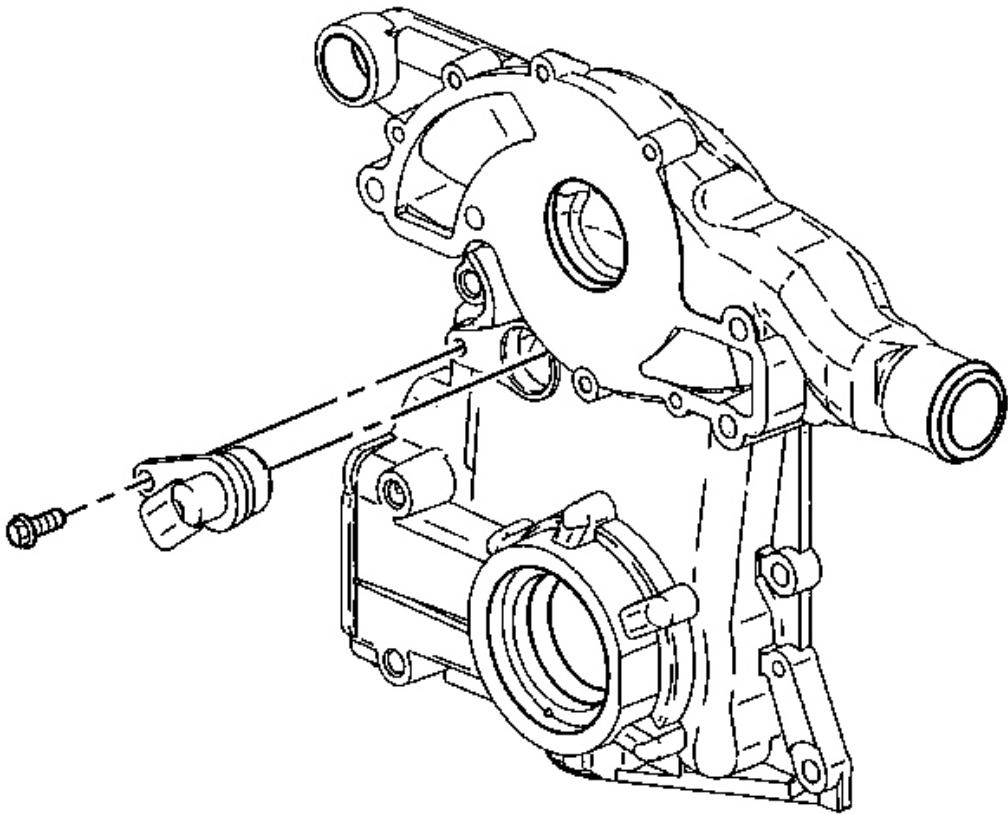
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**Fig. 140: Identifying Oil Pump Cover & Gear Set**  
Courtesy of GENERAL MOTORS CORP.

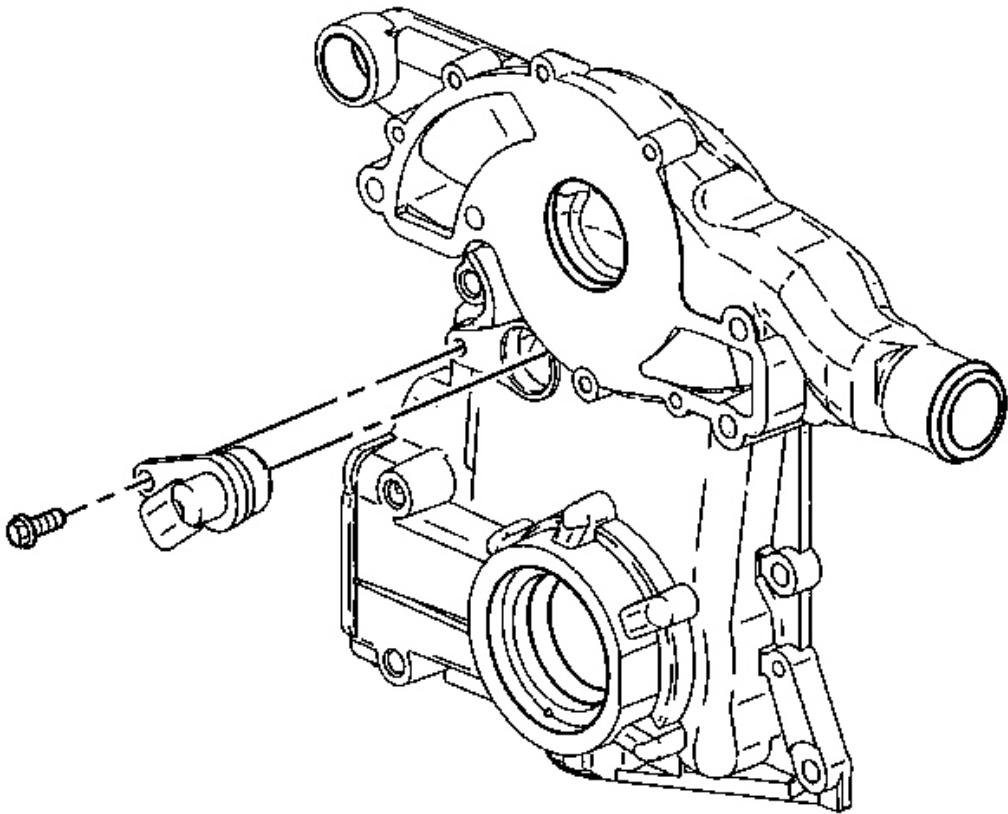
38. Remove the oil pump gear set.



**Fig. 141: Identifying Camshaft Position Sensor**

Courtesy of GENERAL MOTORS CORP.

39. Remove the CMP sensor bolt.
40. Remove the CMP sensor.
41. Inspect the timing chain for overall in and out movement. Maximum movement is 25.4 mm (1 in). Refer to **Timing Chain and Sprockets Cleaning and Inspection**.
42. Inspect the sprockets for wear.
43. Clean and inspect the water pump. Refer to **Water Pump Cleaning and Inspection**.
44. Clean and inspect the oil pump. Refer to **Oil Pump Cleaning and Inspection**.
45. Clean the engine front cover mating surfaces.



**Fig. 142: Identifying Camshaft Position Sensor**

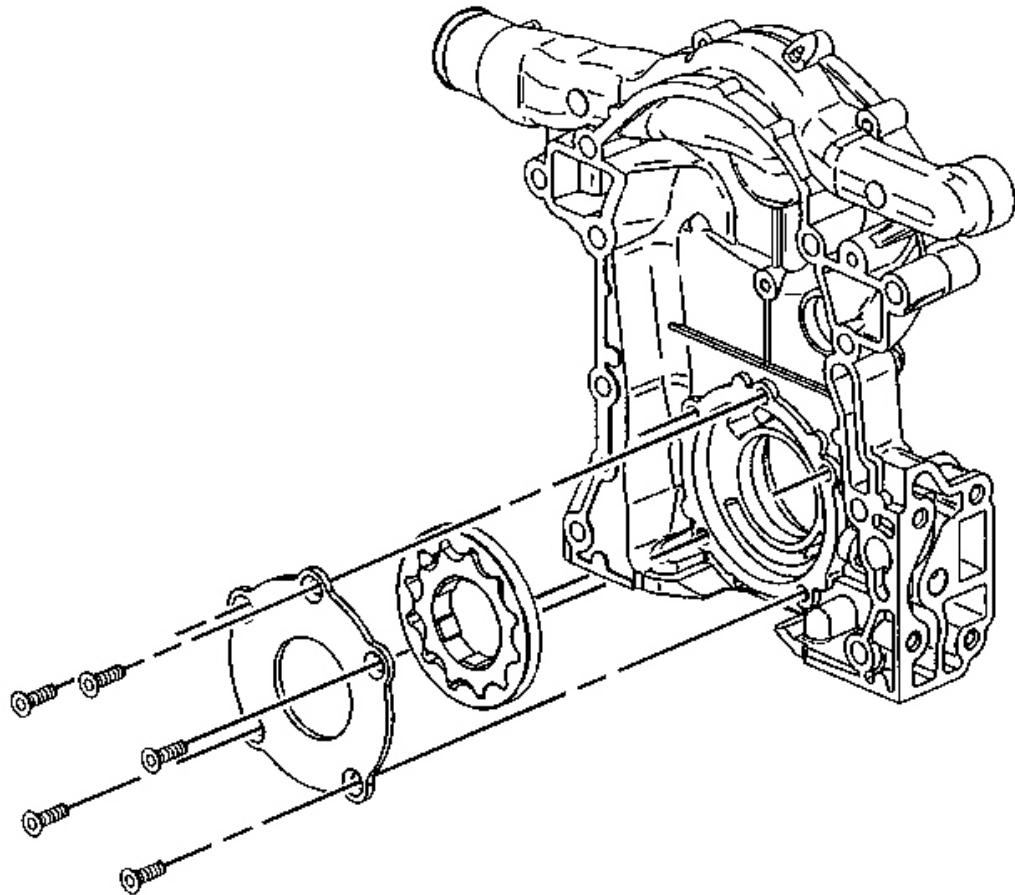
Courtesy of GENERAL MOTORS CORP.

1. If replacing the engine front cover refer to the following steps, otherwise proceed to step 14.
2. Install the CMP sensor.

**NOTE: Refer to Fastener Notice .**

3. Install the CMP sensor bolt.

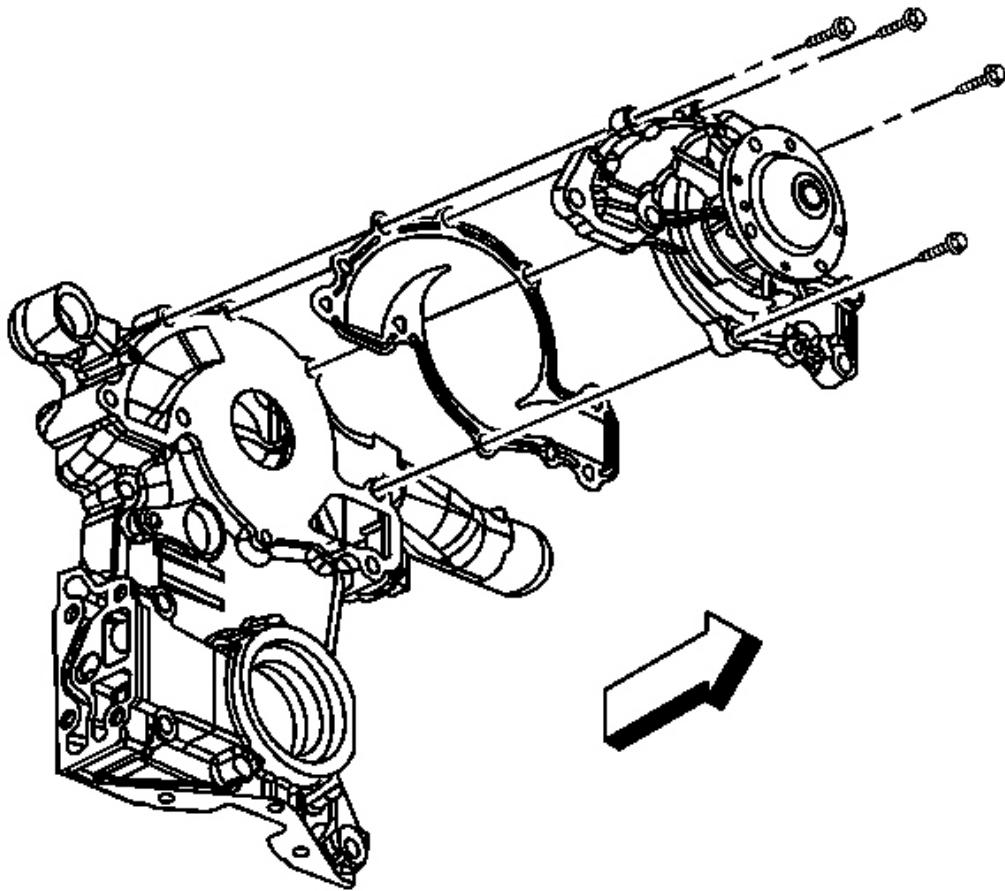
**Tighten:** Tighten the bolt to 10 N.m (89 lb in).



**Fig. 143: Identifying Oil Pump Cover & Gear Set**  
Courtesy of GENERAL MOTORS CORP.

4. Lubricate the oil pump gear set with petroleum jelly.
5. Install the oil pump gear set.
6. Pack the oil pump gears with petroleum jelly.
7. Install the oil pump cover.
8. Install the oil pump cover screws.

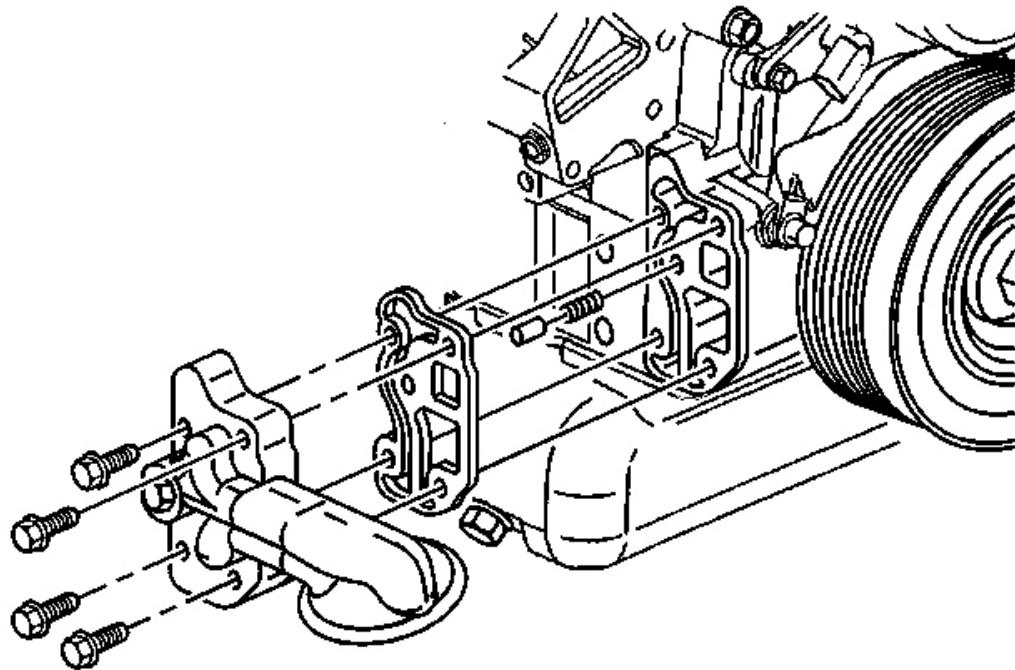
**Tighten:** Tighten the screws to 11 N.m (98 lb in).



**Fig. 144: Water Pump Assembly**  
Courtesy of GENERAL MOTORS CORP.

9. Position the water pump gasket and water pump.
10. Install the water pump bolts.

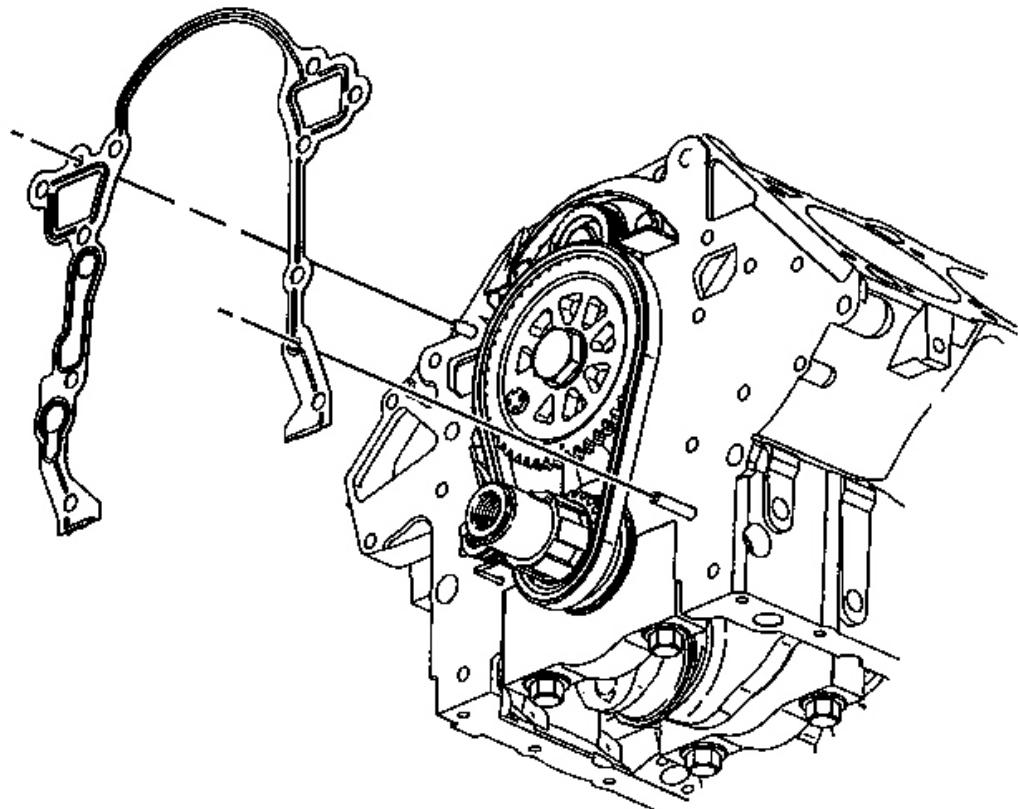
**Tighten:** Tighten the bolts to 15 N.m (11 lb ft) plus an additional 80 degrees using **J 45059**. See Special Tools.



**Fig. 145: Removing/Installing Oil Filter Adapter & Pressure Relief Valve**  
Courtesy of GENERAL MOTORS CORP.

11. Install the pressure relief valve spring and valve.
12. Position the oil filter adapter gasket and adapter.
13. Install the oil filter adapter bolts.

**Tighten:** Tighten the bolts to 50 N.m (30 lb ft) plus an additional 3 degrees using **J 45059** .  
See Special Tools.



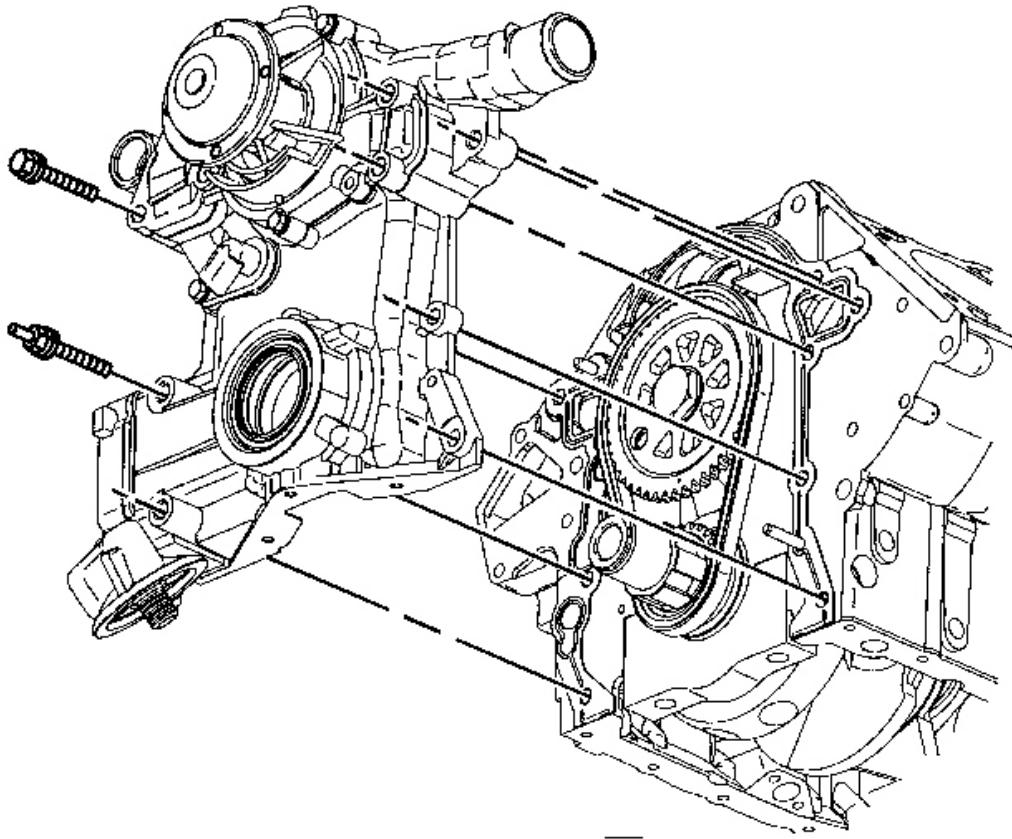
**Fig. 146: Identifying Engine Front Cover Gasket**

Courtesy of GENERAL MOTORS CORP.

14. Install a NEW engine front cover gasket.
15. Apply sealer to the engine front cover bolts/stud threads. Refer to Sealers, Adhesives and Lubricants for the correct part number.

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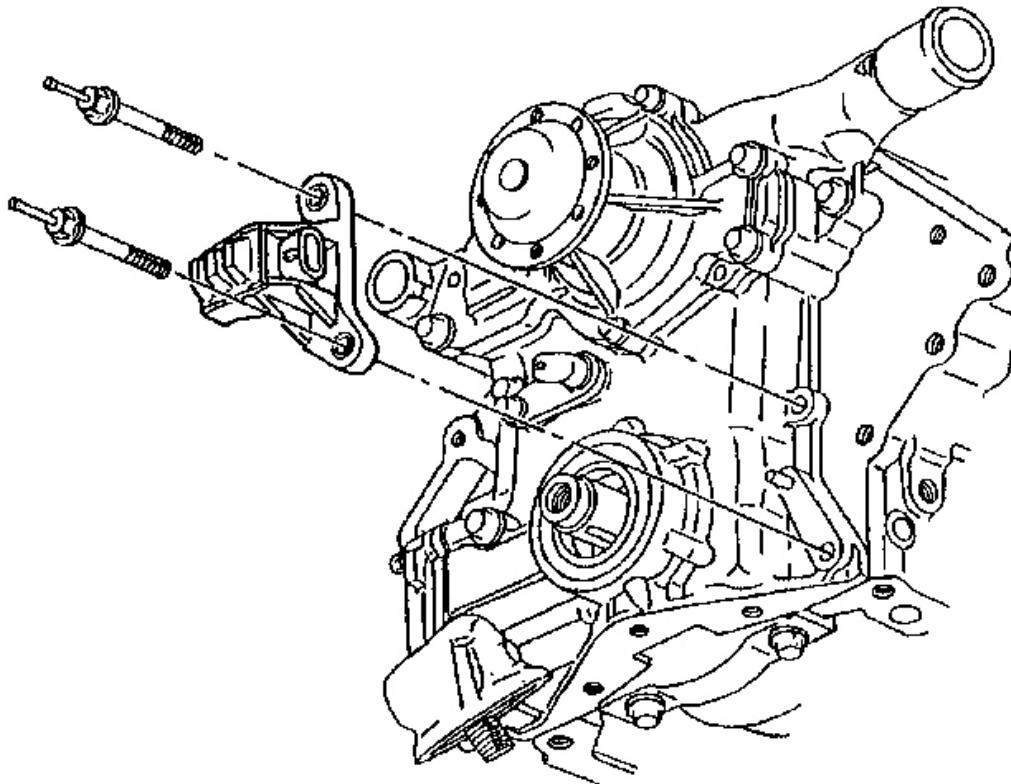
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**Fig. 147: View Of Engine Front Cover & Oil Filter Adapter**  
Courtesy of GENERAL MOTORS CORP.

16. Install the engine front cover.
17. Install the engine front cover bolts/stud.

**Tighten:** Tighten the bolts to 20 N.m (15 lb ft) plus an additional 40 degrees using **J 45059**. See **Special Tools**.

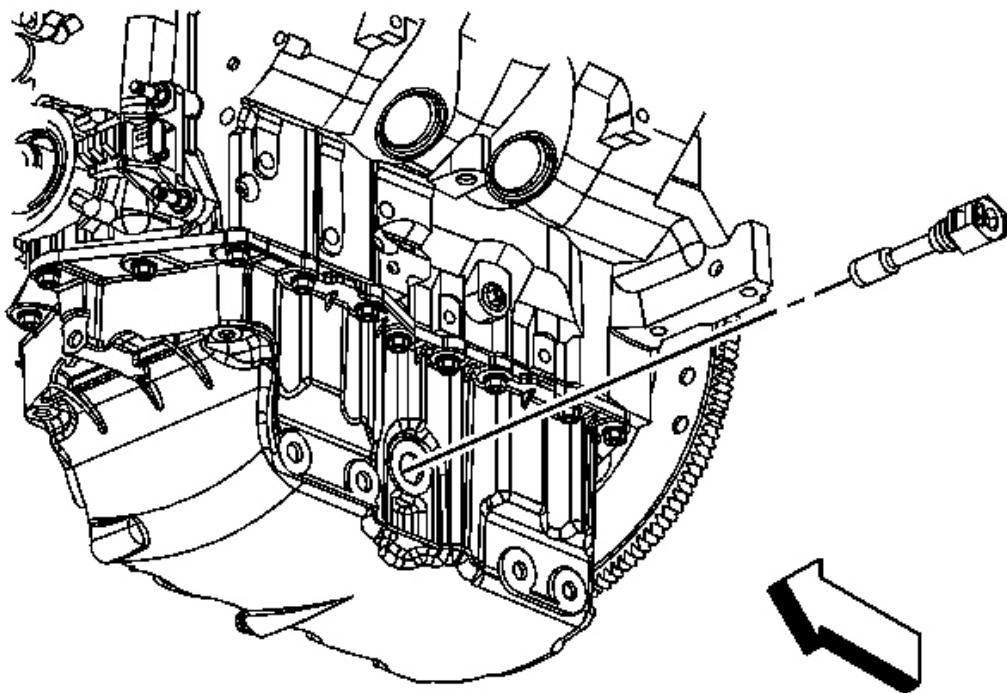


**Fig. 148: Identifying Crankshaft Position Sensor**  
Courtesy of GENERAL MOTORS CORP.

18. Install the CKP sensor and studs.

**Tighten:** Tighten the studs to 20 N.m (15 lb ft) plus an additional 40 degrees using **J 45059**. See [Special Tools](#).

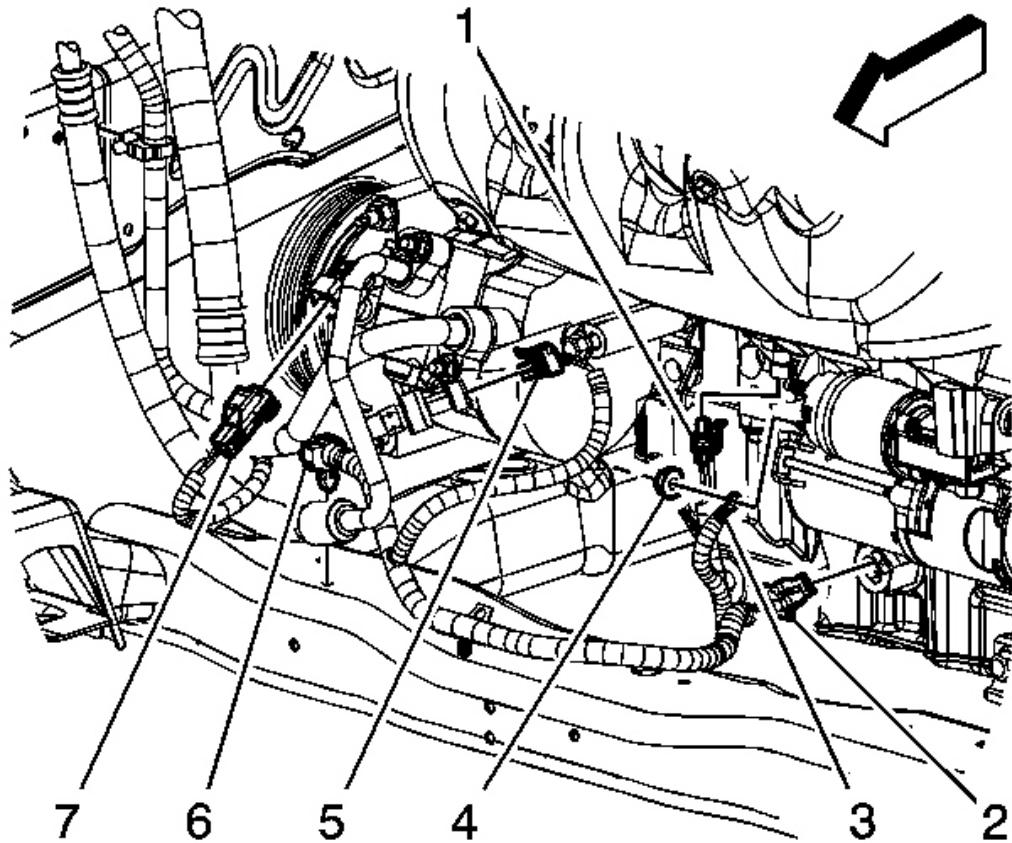
19. Install the oil pan. Refer to [Oil Pan Replacement](#)



**Fig. 149: Identifying Oil Level Sensor**  
Courtesy of GENERAL MOTORS CORP.

20. Install the oil level sensor.

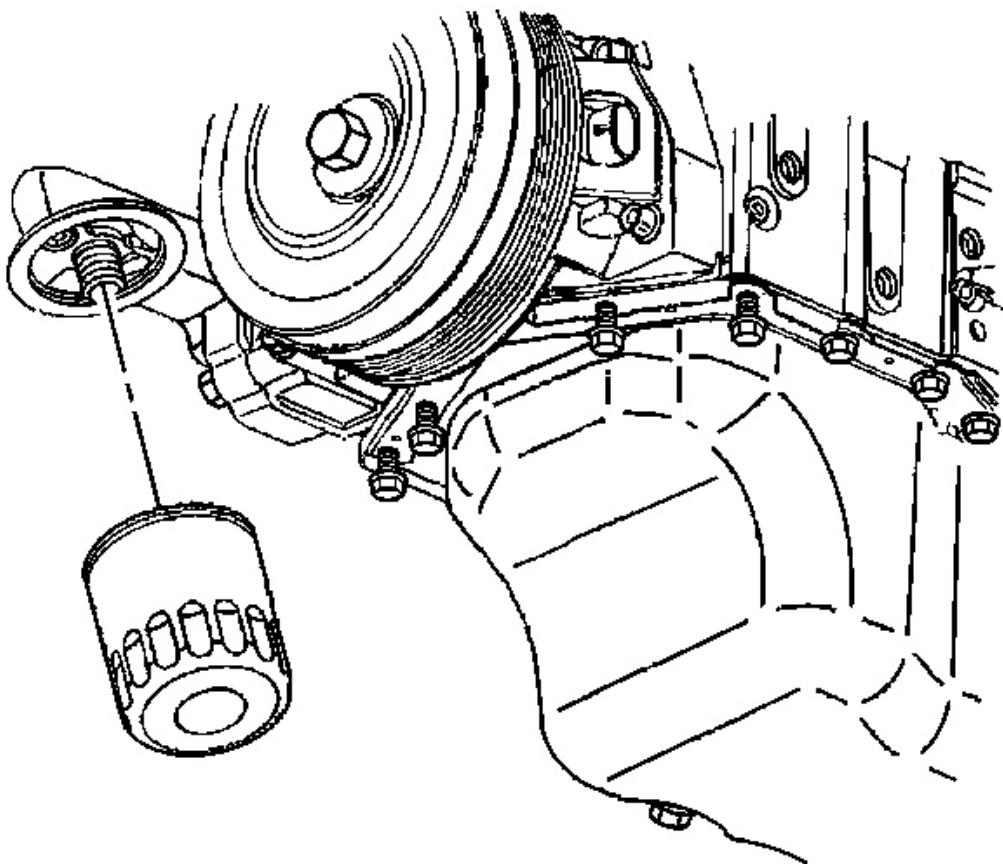
**Tighten:** Tighten the sensor to 20 N.m (15 lb ft).



**Fig. 150: Identifying Stater & Cable Components**

Courtesy of GENERAL MOTORS CORP.

21. Connect the engine harness electrical connector (2) to the oil level sensor.



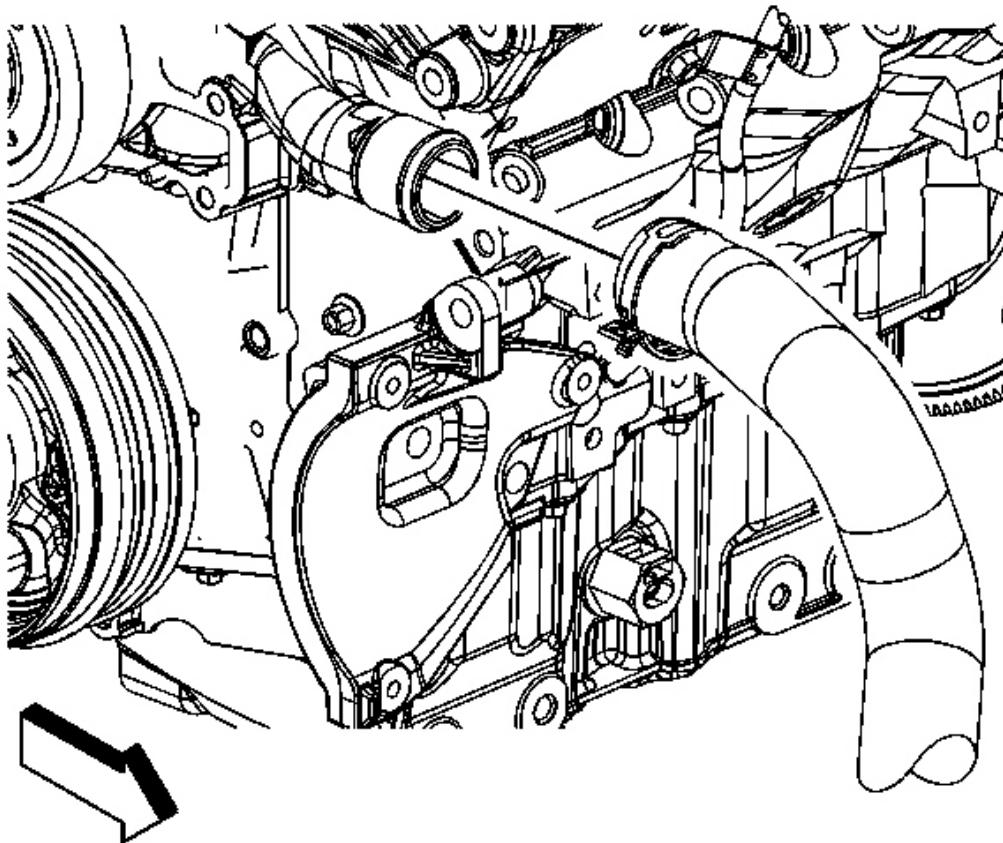
**Fig. 151: Identifying Oil Filter**

Courtesy of GENERAL MOTORS CORP.

22. Install the oil filter.

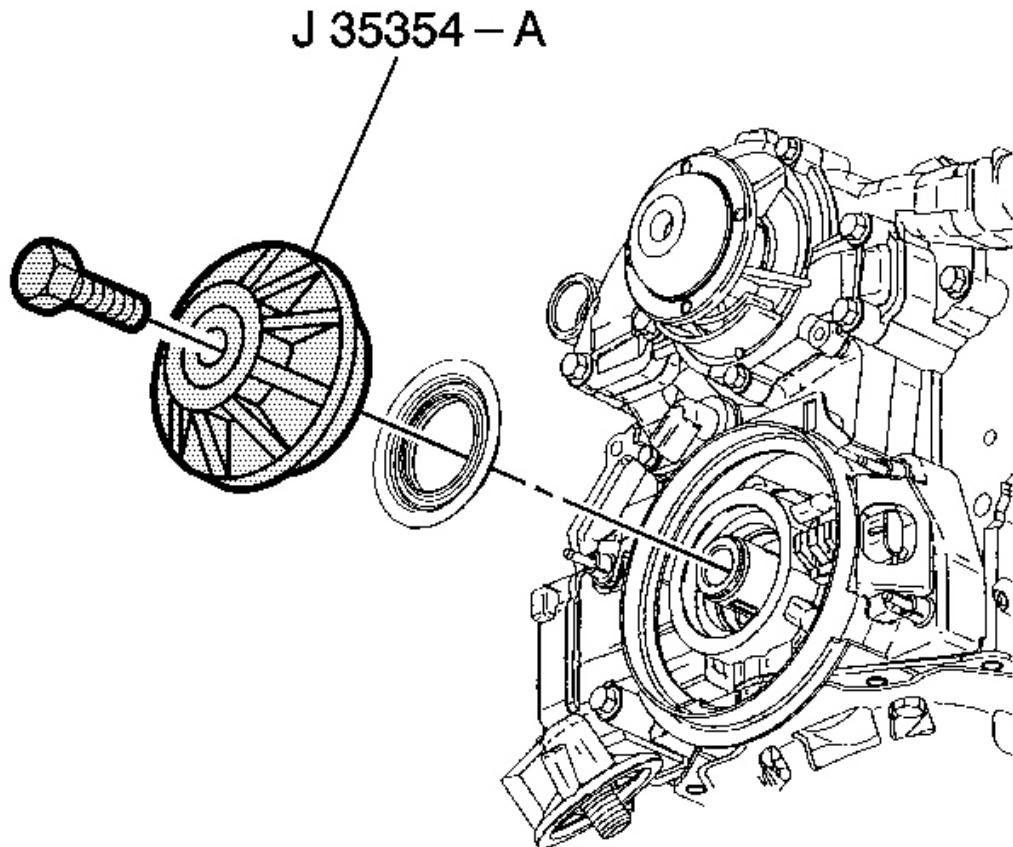
**Tighten:** Tighten the filter to 30 N.m (22 lb ft).

23. Install the engine mount bracket. Refer to [Engine Front Mount Bracket Replacement](#).



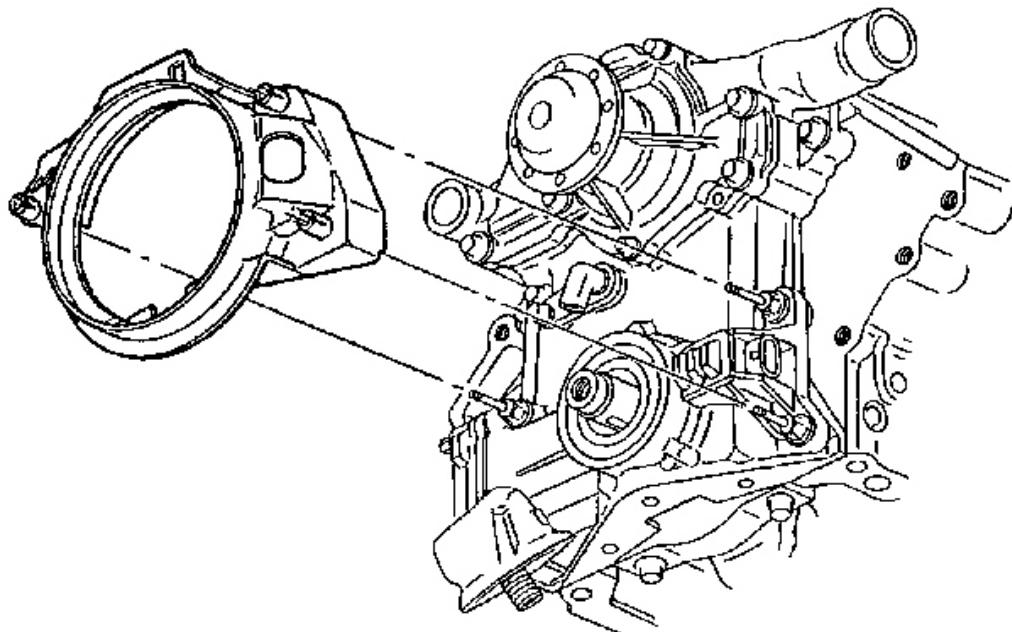
**Fig. 152: View Of Radiator Outlet Hose**  
Courtesy of GENERAL MOTORS CORP.

24. Lower the vehicle.
25. Remove the engine support fixture.
26. Raise the vehicle.
27. Install the radiator outlet hose to the engine front cover.
28. Using the **J 38185** position the radiator outlet hose clamp. See **Special Tools**.



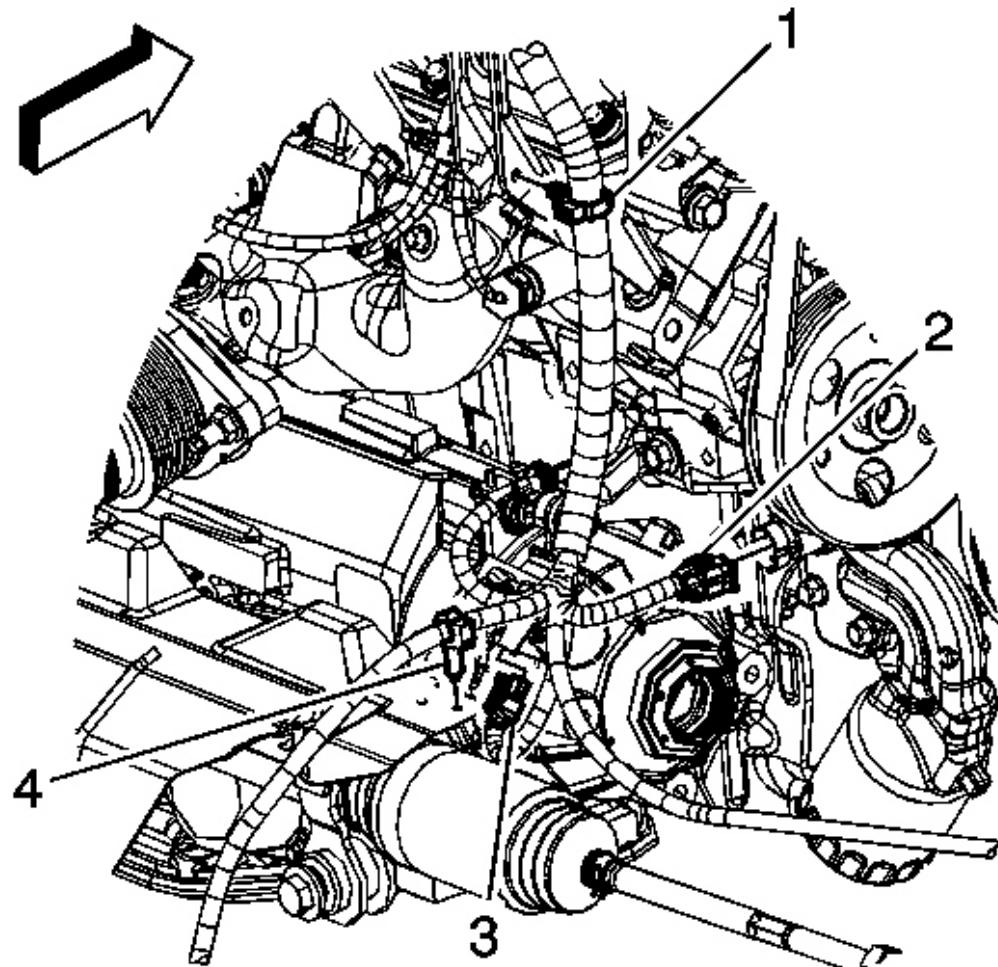
**Fig. 153: Installing Crankshaft Front Oil Seal Using J 35354-A**  
Courtesy of GENERAL MOTORS CORP.

29. Install the NEW engine front cover seal using **J 35354-A** .
30. Tighten the bolt until the crankshaft front oil seal is seated in the engine front cover.
31. Remove the **J 35354-A** .



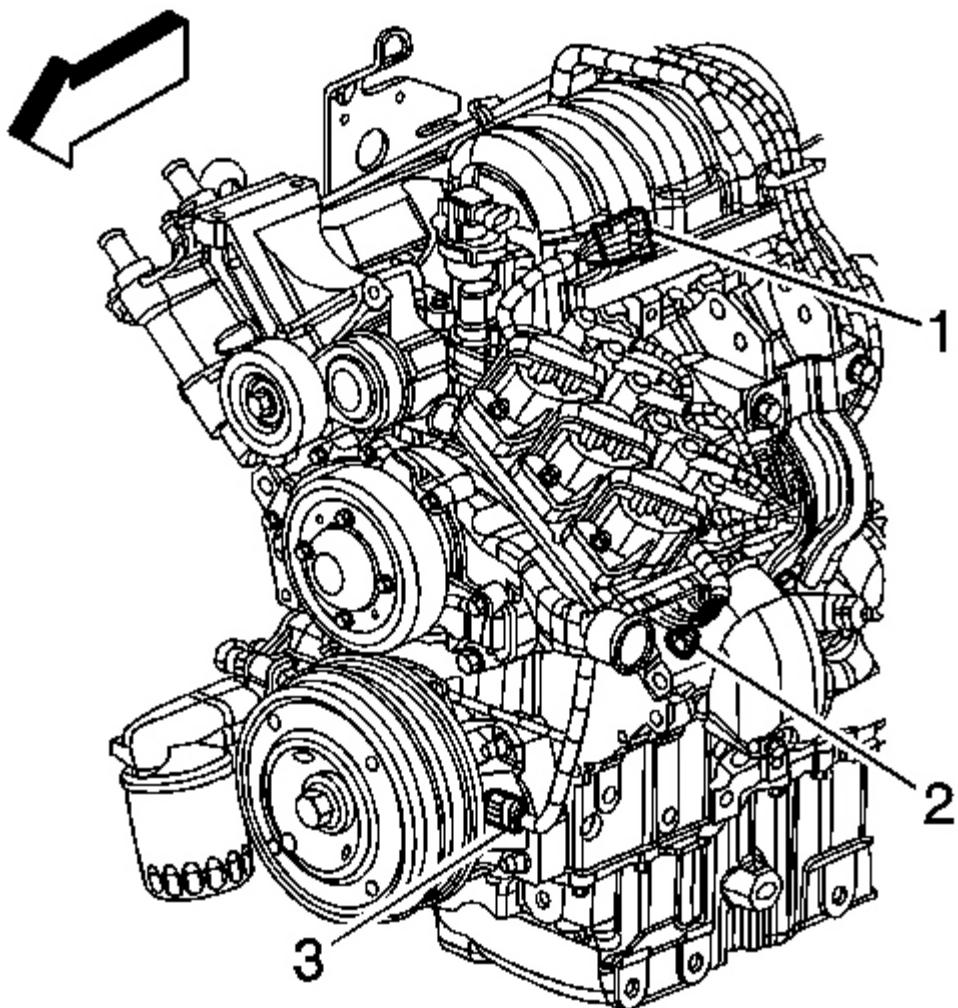
**Fig. 154: Identifying Crankshaft Position Sensor Shield**  
Courtesy of GENERAL MOTORS CORP.

32. Install the CKP sensor shield.



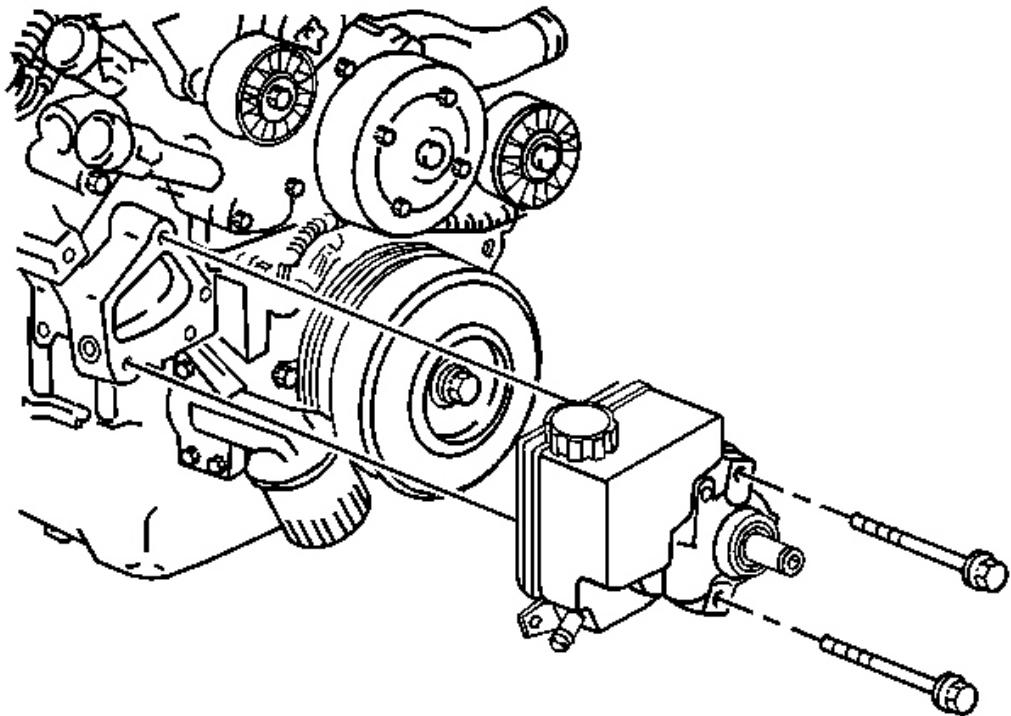
**Fig. 155: Identifying Oil Pressure Sensor Connector**  
Courtesy of GENERAL MOTORS CORP.

33. Connect the engine harness electrical connector (2) to the oil pressure sensor.



**Fig. 156: Identifying Ignition Control Module Wiring Harness Electrical Connector**  
Courtesy of GENERAL MOTORS CORP.

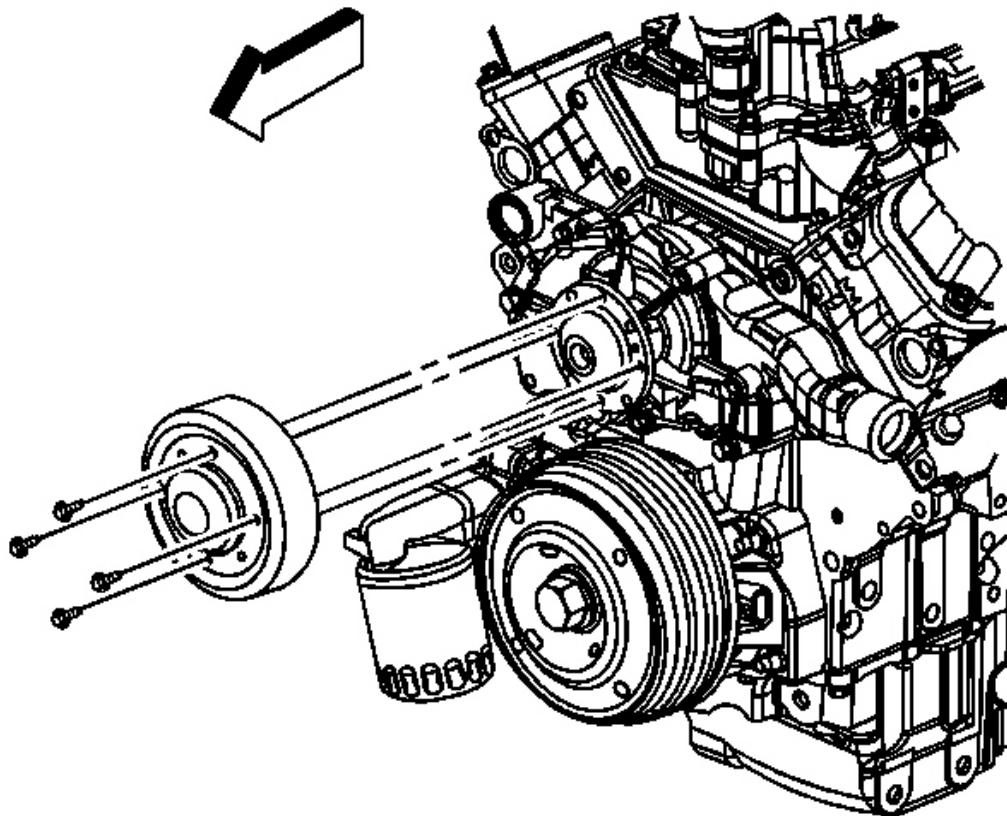
34. Connect the ignition control module wiring harness electrical connector (3) to the CKP sensor.



**Fig. 157: View Of Power Steering Pump And Mounting Bolts**  
Courtesy of GENERAL MOTORS CORP.

35. Install the crankshaft balancer. Refer to [Crankshaft Balancer Replacement](#).
36. Lower the vehicle.
37. Position and install the power steering pump and bolts.

**Tighten:** Tighten the bolts to 34 N.m (25 lb ft).



**Fig. 158: Identifying Water Pump Pulley & Bolts**  
Courtesy of GENERAL MOTORS CORP.

38. Install the water pump pulley.
39. Install the drive belt tensioner. Refer to [\*\*Drive Belt Tensioner Replacement\*\*](#).
40. Tighten the water pump pulley bolts.

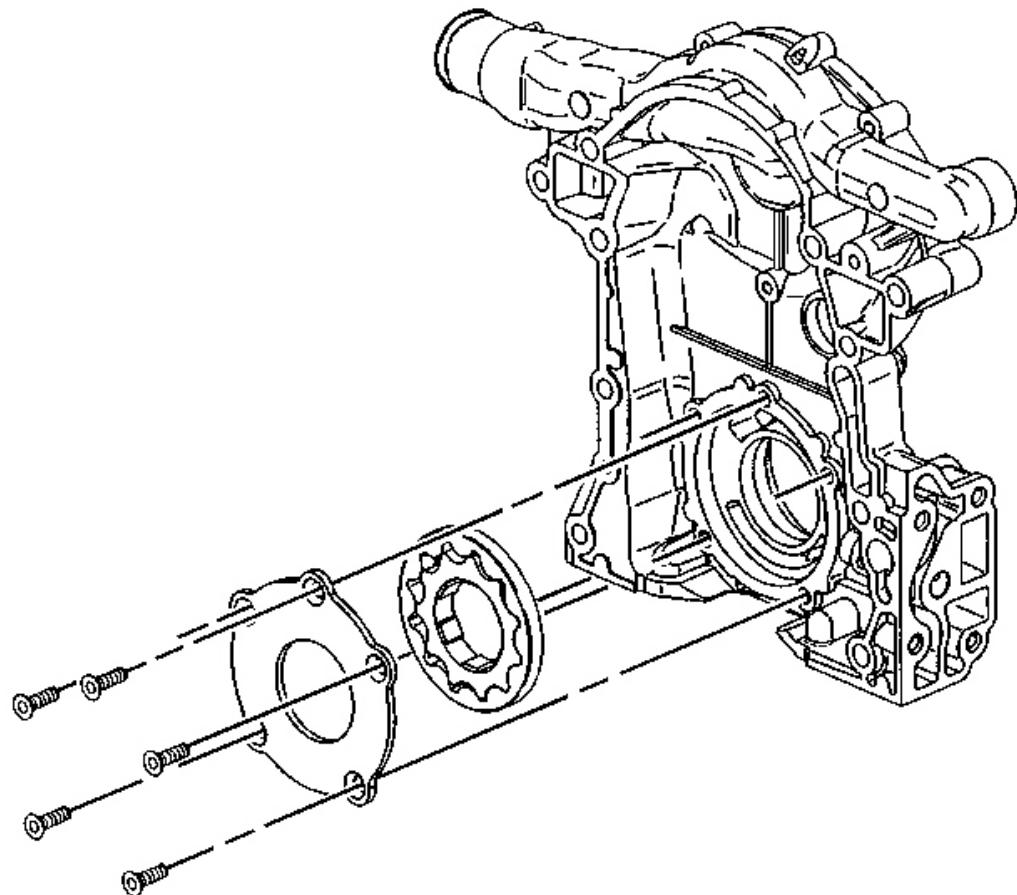
**Tighten:** Tighten the bolts to 13 N.m (115 lb in).

41. Fill the cooling system. Refer to [\*\*Cooling System Draining and Filling \(Static Fill\)\*\*](#) or [\*\*Cooling System Draining and Filling \(Vac-N-Fill\)\*\*](#) .
42. Fill the crankcase with engine oil. Refer to [\*\*Engine Oil and Oil Filter Replacement\*\*](#).
43. Inspect for leaks.
44. Perform the CKP system variation learn procedure. Refer to [\*\*Crankshaft Position System\*\*](#)

## Variation Learn

### OIL PUMP COVER AND GEAR SET REPLACEMENT

#### Removal Procedure

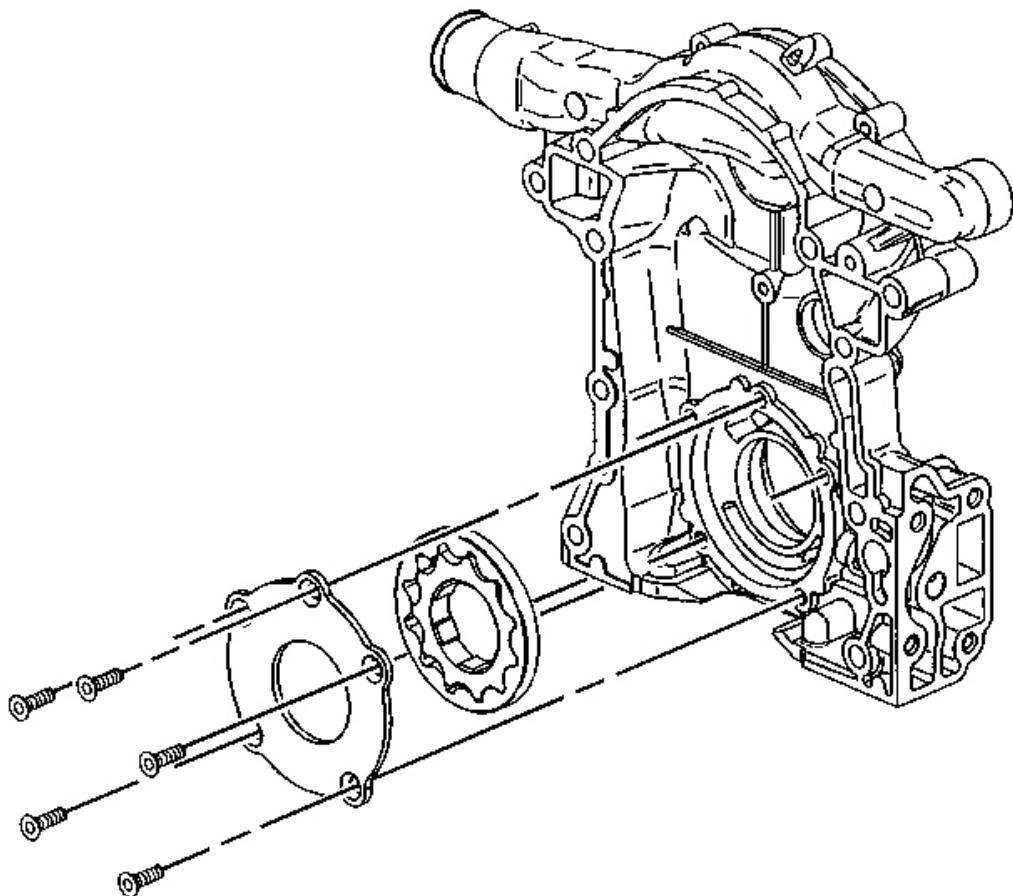


**Fig. 159: Identifying Oil Pump Cover & Gear Set**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine front cover. Refer to [Engine Front Cover Replacement](#).
2. Remove the oil pump cover screws.
3. Remove the oil pump cover.
4. Remove the oil pump gear set.

5. Clean and Inspect the oil pump. Refer to [Oil Pump Cleaning and Inspection](#).

**Installation Procedure**



**Fig. 160: Identifying Oil Pump Cover & Gear Set**  
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the oil pump gear set with petroleum jelly.
2. Install the oil pump gear set.
3. Pack the oil pump gears with petroleum jelly.
4. Install the oil pump cover.

**NOTE:** Refer to Fastener Notice .

5. Install the oil pump cover screws.

**Tighten:** Tighten the screws to 11 N.m (98 lb in).

6. Install the engine front cover. Refer to Engine Front Cover Replacement.

**NOTE:** Do not run the engine until the oil pressure is tested. Running the engine without measurable oil pressure will cause extensive damage.

**NOTE:** Stop the engine and remove the oil pan if the oil pressure does not build up immediately. Check the oil pump pipe and the screen for a clogged screen, damaged pipe or a damaged gasket. Running the engine without measurable oil pressure will cause extensive damage.

7. Inspect the oil pressure.

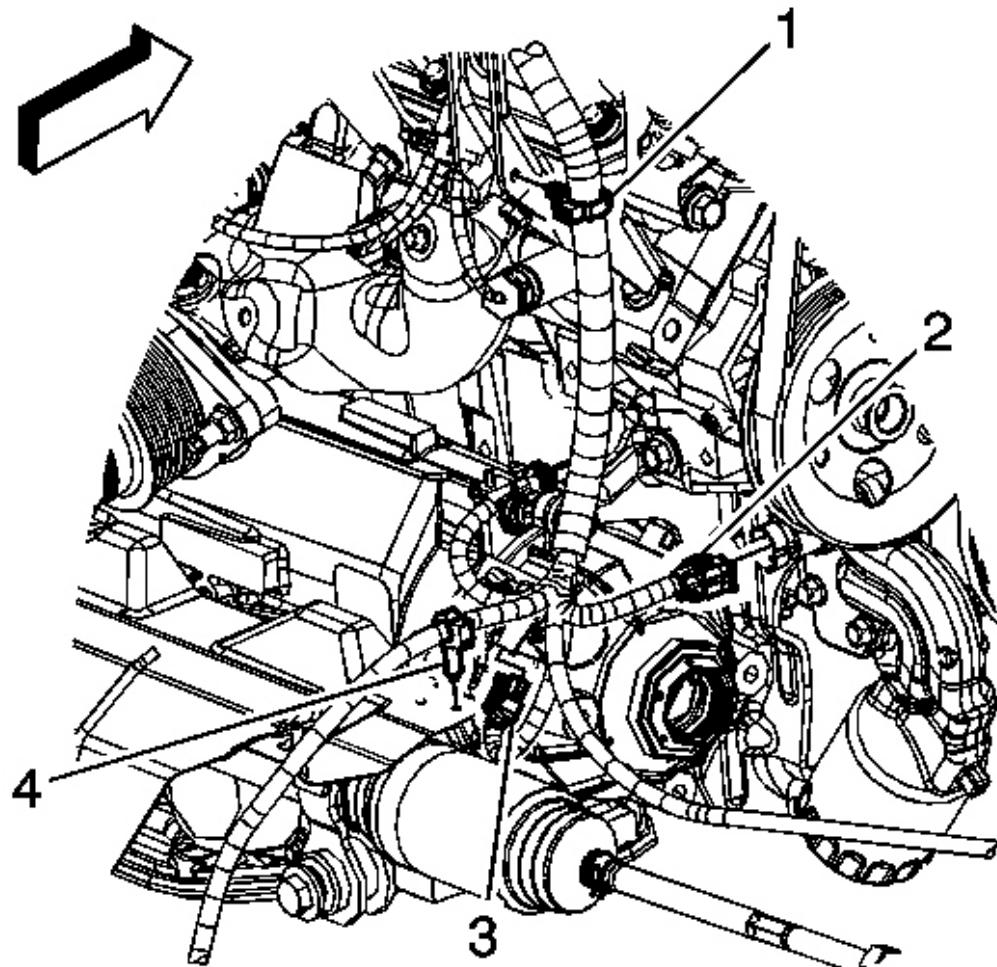
8. Inspect for leaks.

## OIL FILTER ADAPTER AND BYPASS VALVE ASSEMBLY REPLACEMENT

### Tools Required

**J 45059** Angle Meter. See Special Tools.

### Removal Procedure

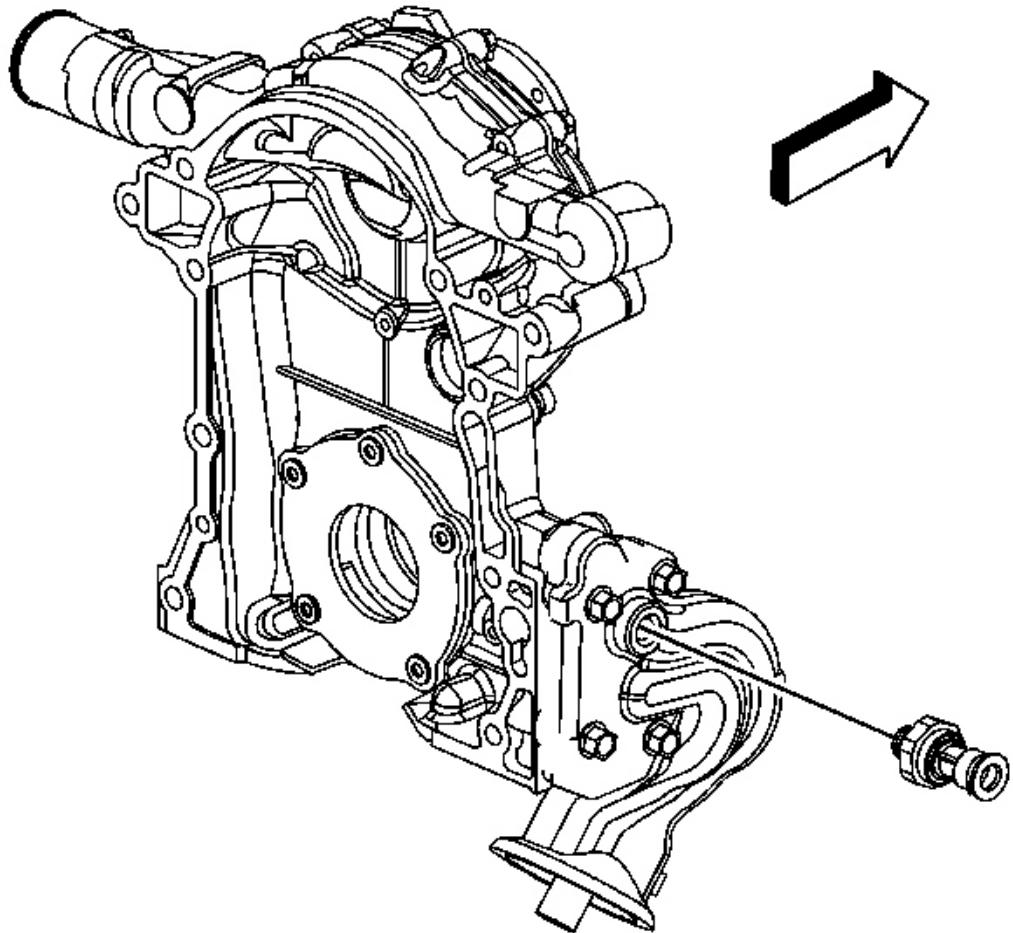


**Fig. 161: View Of Left side Engine Compartment Components**  
Courtesy of GENERAL MOTORS CORP.

1. Drain the engine oil and remove the oil filter. Refer to [Engine Oil and Oil Filter Replacement](#).
2. Remove the right side wheel drive shaft. Refer to [Wheel Drive Shaft Replacement](#).
3. Disconnect the engine harness electrical connector (2) from the oil pressure sensor.

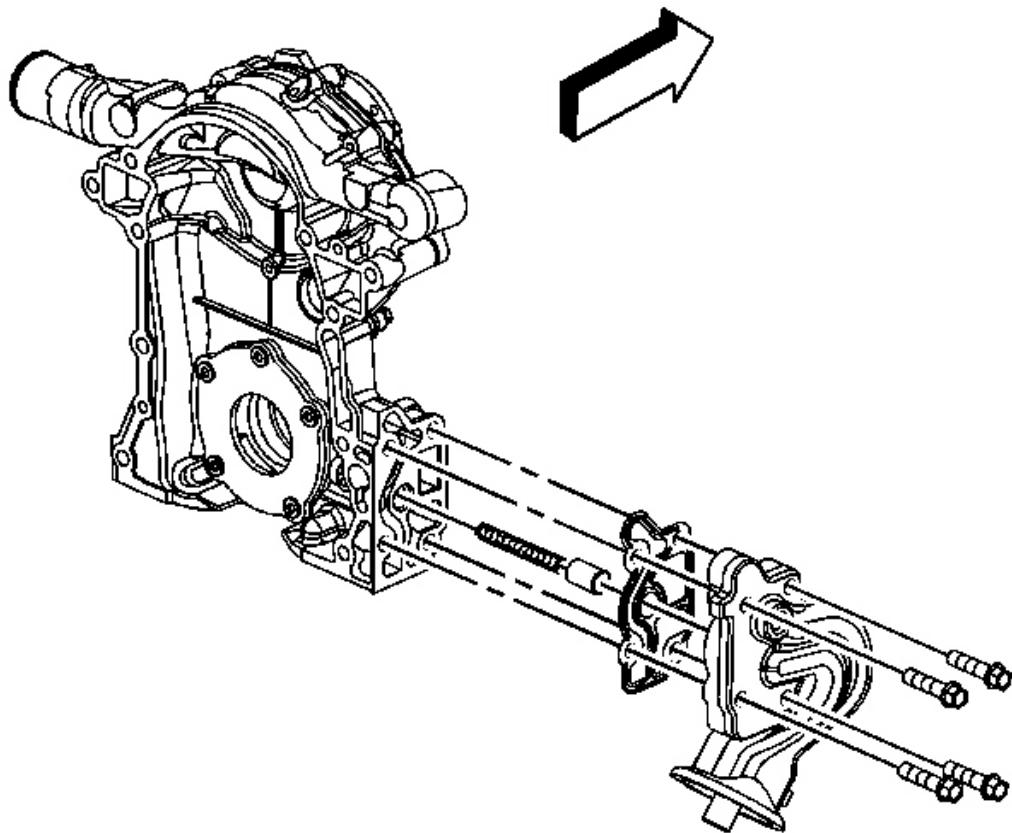
**2006 Buick Lucerne CXS**

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**Fig. 162: Identifying Oil Pressure Sensor**  
Courtesy of GENERAL MOTORS CORP.

4. Remove the oil pressure sensor.

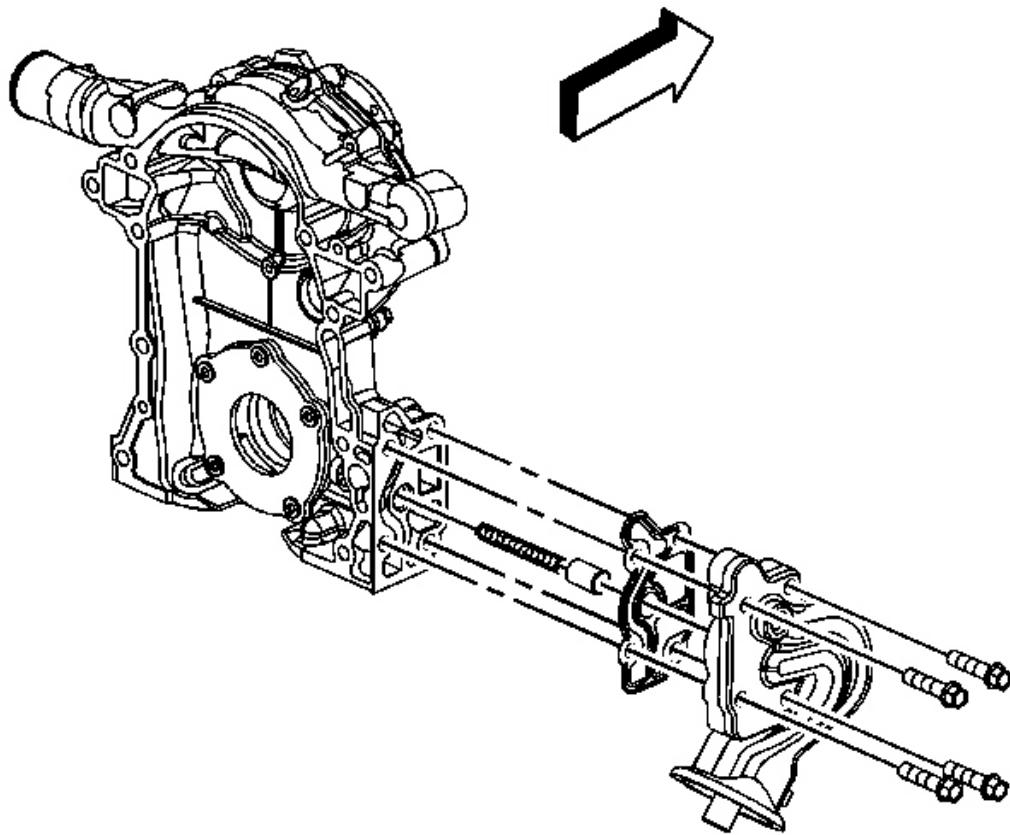


**Fig. 163: Identifying Oil Filter Adapter & Bolts**

Courtesy of GENERAL MOTORS CORP.

5. Remove the oil filter adapter bolts.
6. Remove the oil filter adapter and gasket.
7. Remove the oil filter pressure relief valve and spring.
8. Clean the parts in a suitable solvent. Dry the parts.
9. Clean the oil filter adapter gasket mating surfaces.

**Installation Procedure**



**Fig. 164: Identifying Oil Filter Adapter & Bolts**

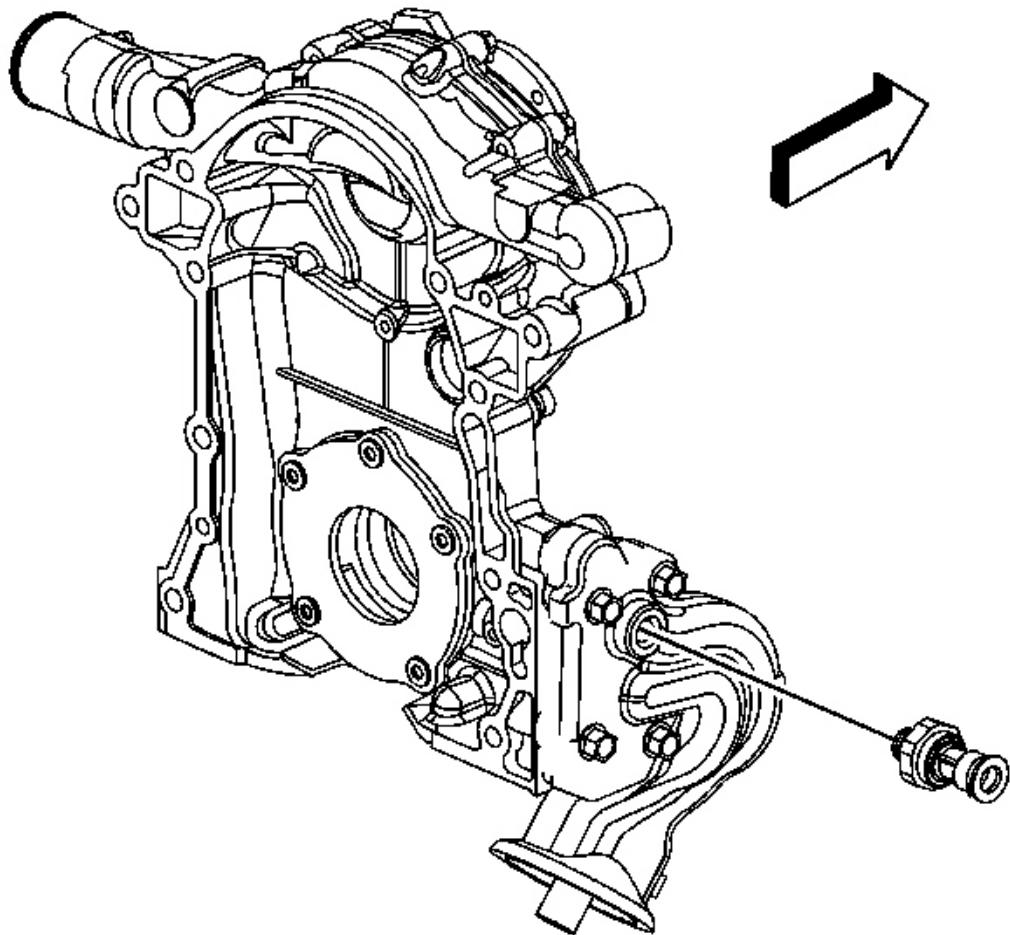
Courtesy of GENERAL MOTORS CORP.

1. Install the oil filter pressure relief valve spring and valve.
2. Position the oil filter adapter gasket and adapter.

**NOTE: Refer to Fastener Notice .**

3. Install the oil filter adapter bolts.

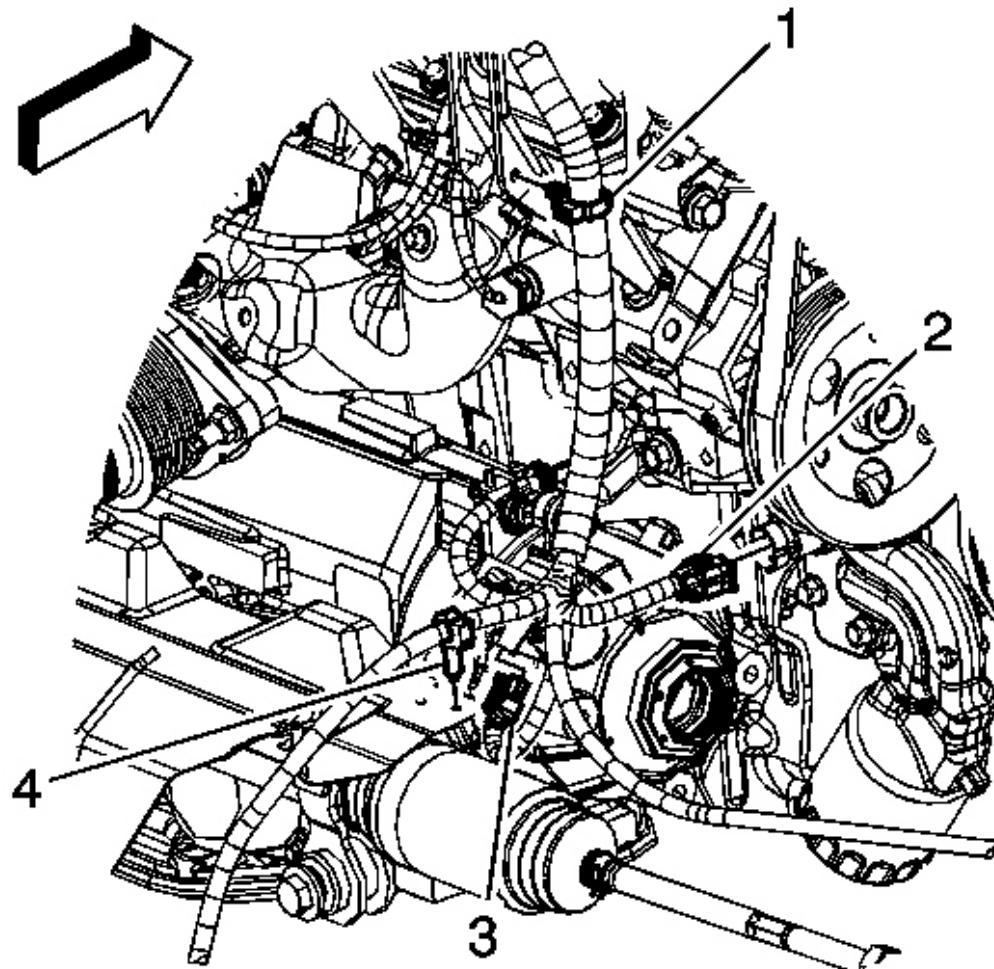
**Tighten:** Tighten the bolts to 50 N.m (37 lb ft) plus an additional 3 degrees using **J 45059** . See Special Tools.



**Fig. 165: Identifying Oil Pressure Sensor**  
Courtesy of GENERAL MOTORS CORP.

4. Install the oil pressure sensor.

**Tighten:** Tighten the sensor to 16 N.m (12 lb ft).



**Fig. 166: View Of Left side Engine Compartment Components**  
Courtesy of GENERAL MOTORS CORP.

5. Connect the engine harness electrical connector (2) to the oil pressure sensor.
6. Install the right side wheel drive shaft. Refer to [Wheel Drive Shaft Replacement](#).
7. Install the oil filter and fill the crankcase. Refer to [Engine Oil and Oil Filter Replacement](#).
8. Inspect for leaks.

Tools Required

**J 45059** Torque Angle Meter. See Special Tools.

Removal Procedure

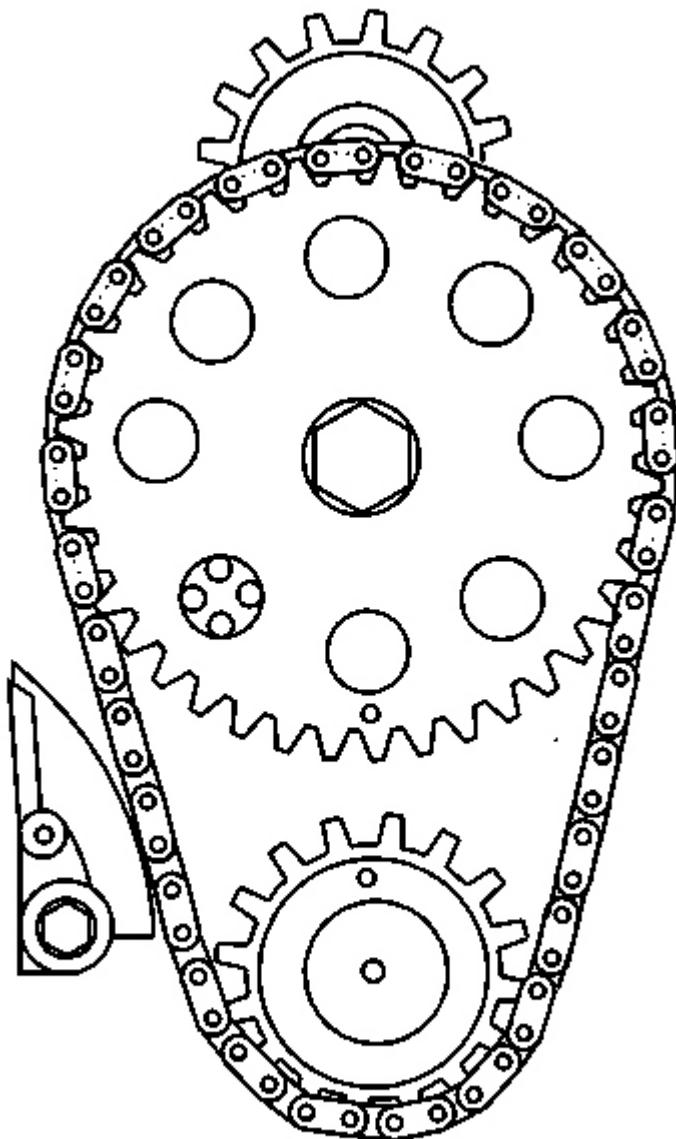
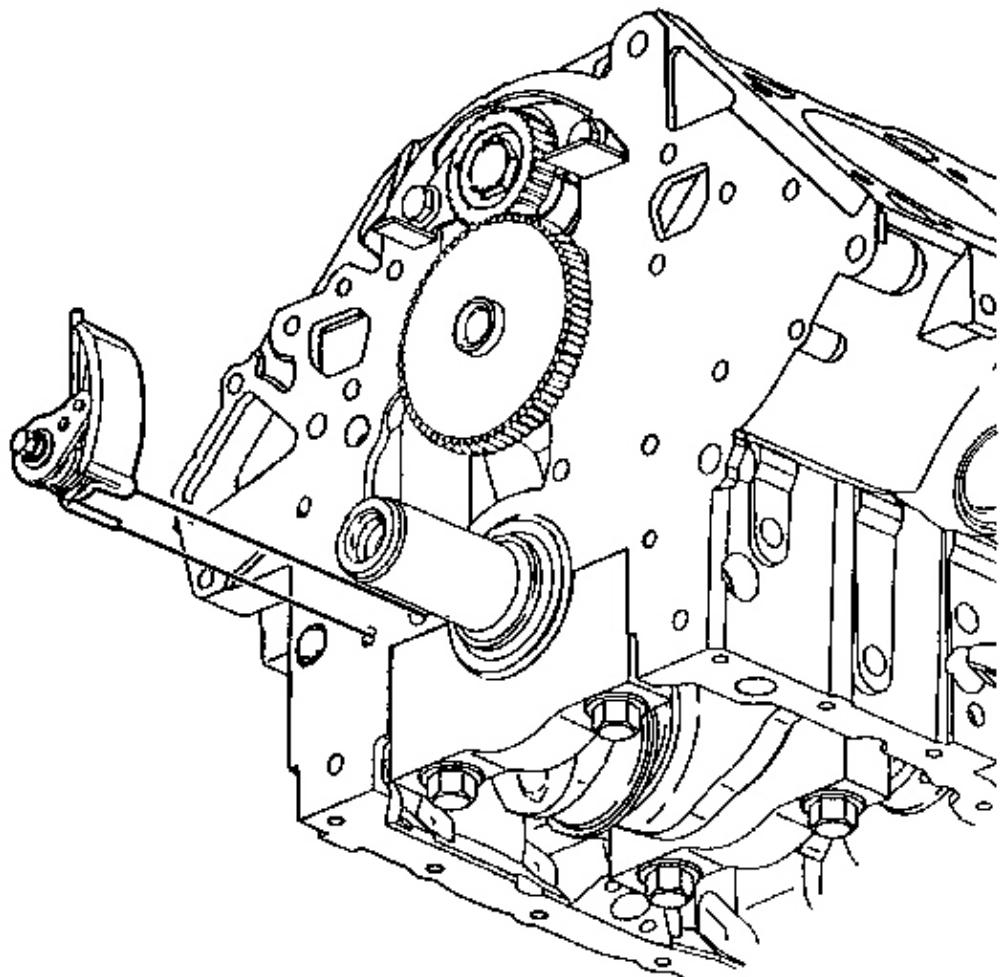


Fig. 167: Aligning Timing Chain & Sprocket Timing Marks

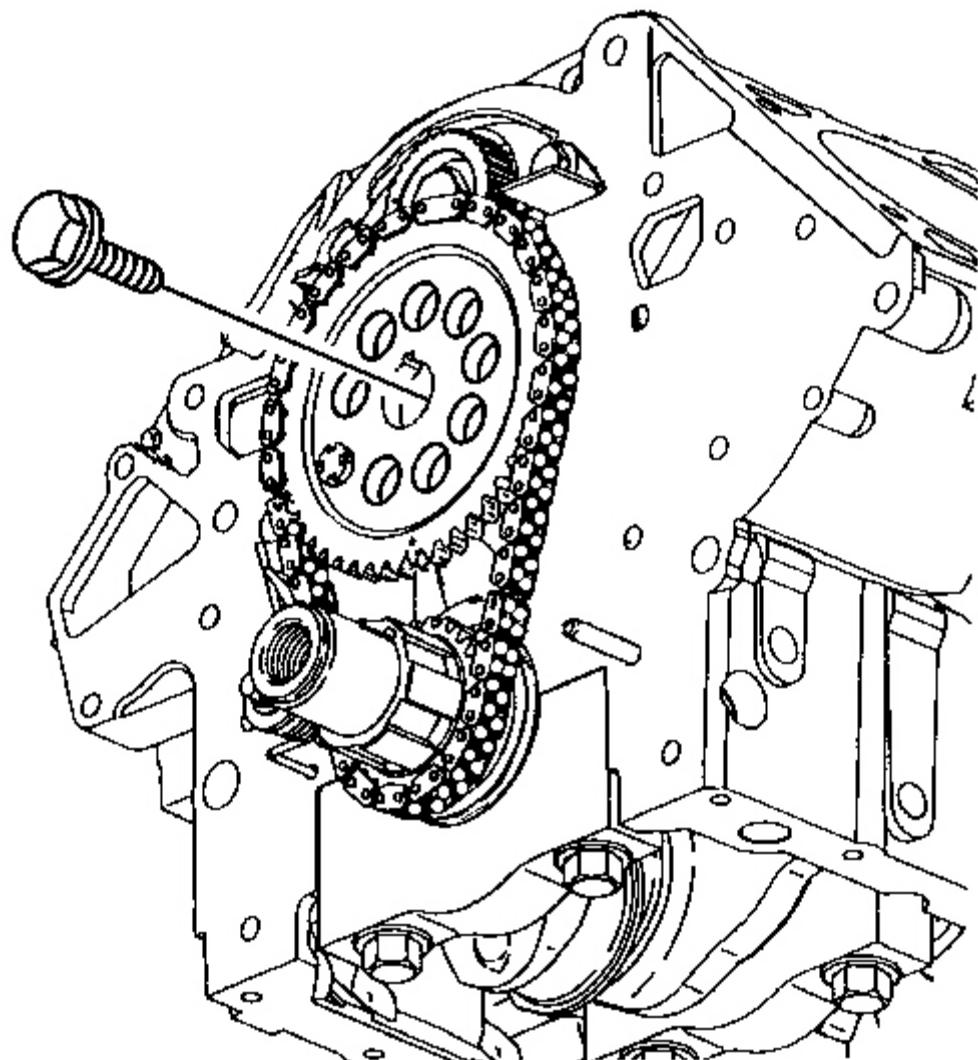
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine front cover. Refer to [Engine Front Cover Replacement](#).
2. Align the timing marks on the sprockets so that they are as close as possible.



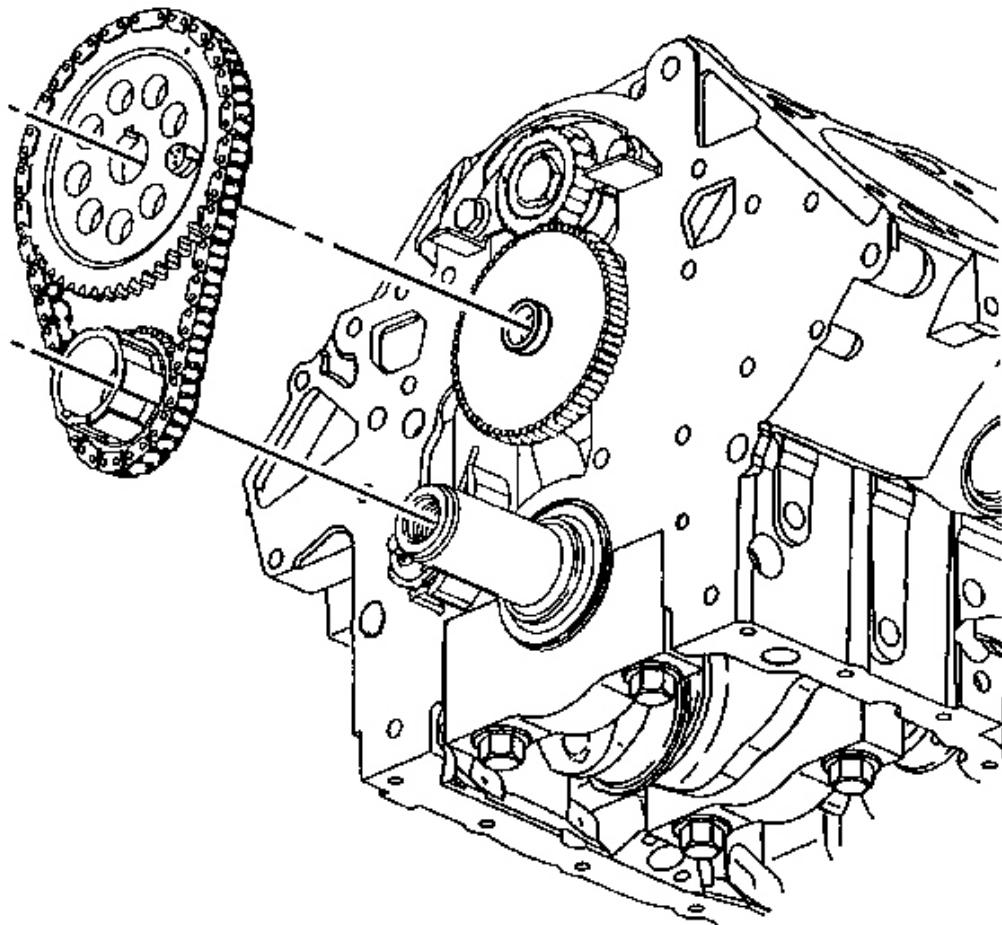
**Fig. 168: Identifying Timing Chain Dampener & Bolt**  
Courtesy of GENERAL MOTORS CORP.

3. Loosen the timing chain dampener bolt.
4. Remove the timing chain dampener.



**Fig. 169: Identifying Camshaft Sprocket Bolt**  
Courtesy of GENERAL MOTORS CORP.

5. Remove the camshaft sprocket bolt.

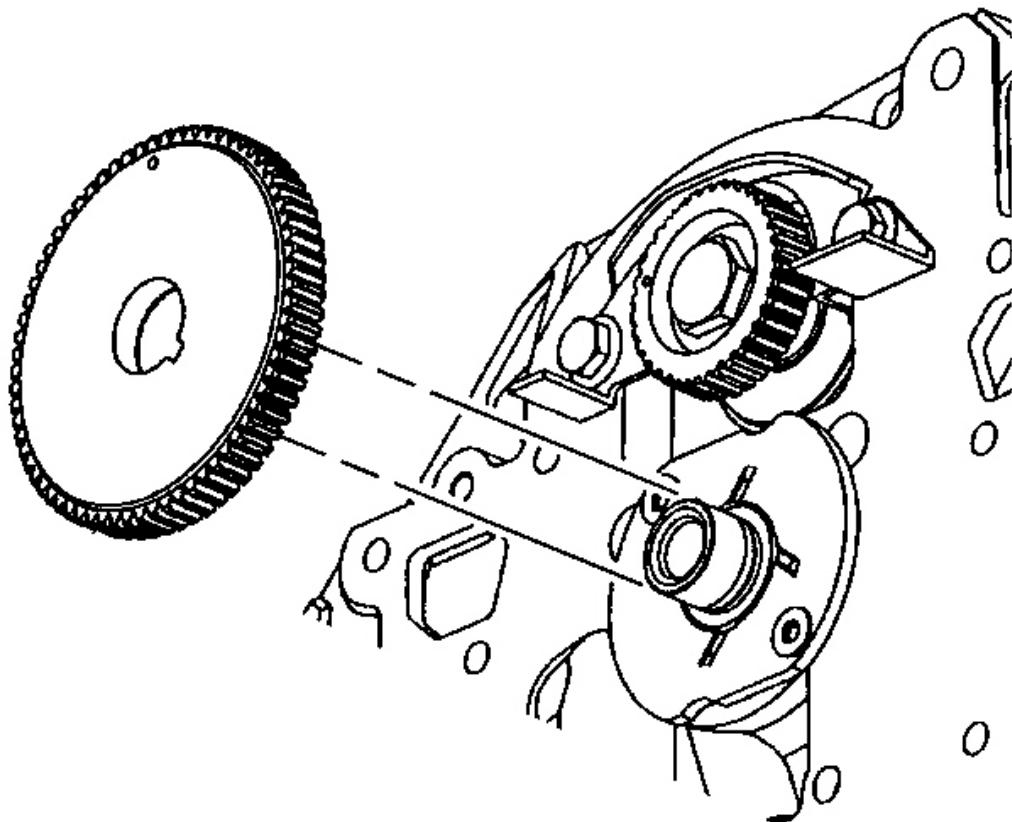


**Fig. 170: Locating Camshaft Sprocket & Timing Chain**  
Courtesy of GENERAL MOTORS CORP.

6. Remove the camshaft sprocket and the timing chain.

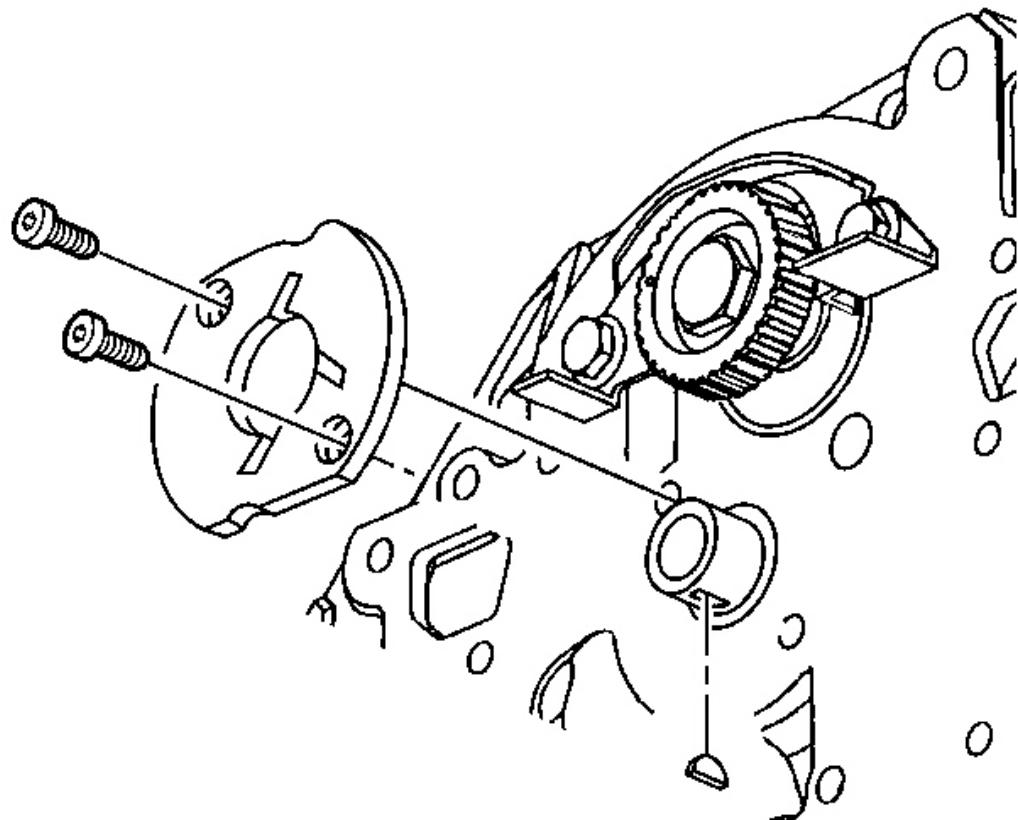
**IMPORTANT: If the sprocket does not come off easily, a light blow on the lower edge of the sprocket with a plastic mallet should dislodge the sprocket.**

7. Remove the crankshaft sprocket.



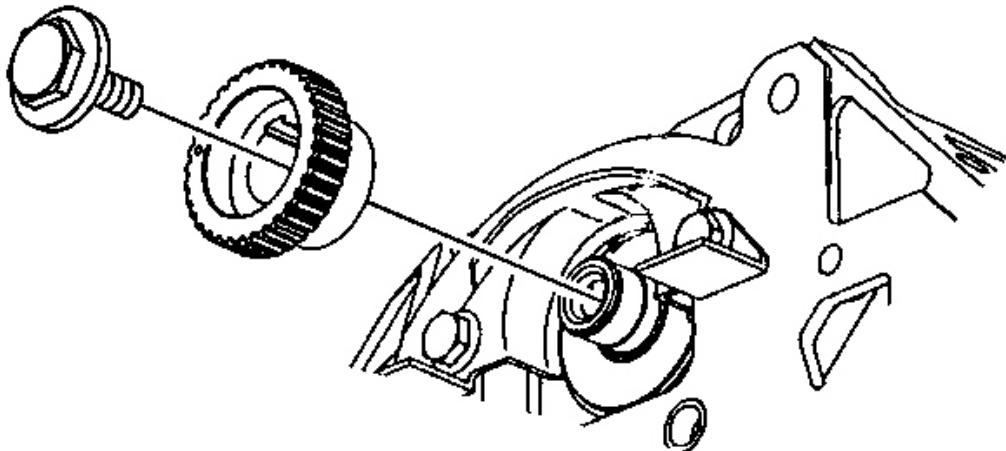
**Fig. 171: View Of Balance Shaft Drive Gear**  
Courtesy of GENERAL MOTORS CORP.

8. Remove the balance shaft drive gear in order to access the camshaft thrust plate, if required.



**Fig. 172: Camshaft Thrust Plate & Bolts**  
Courtesy of GENERAL MOTORS CORP.

9. Remove the camshaft thrust plate bolts, if required.
10. Remove the camshaft thrust plate, if required.

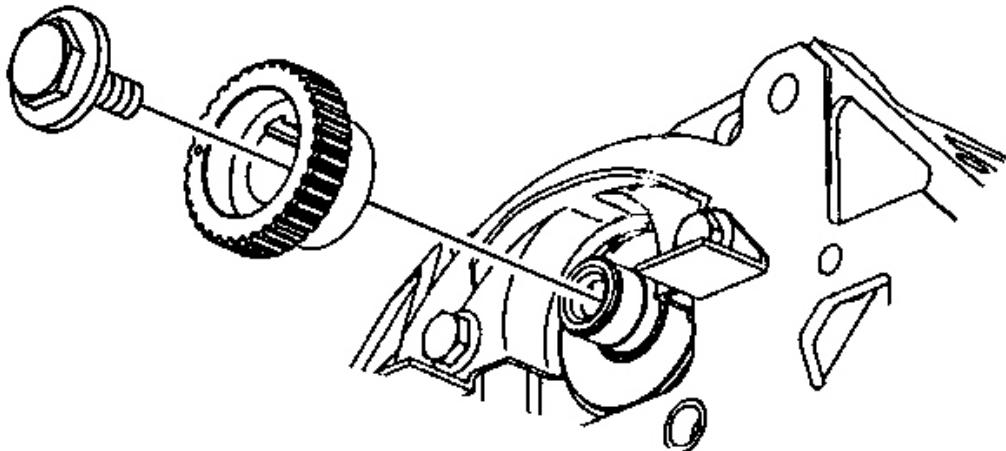


**Fig. 173: Balance Shaft Driven Gear & Bolt**

Courtesy of GENERAL MOTORS CORP.

11. Remove the balance shaft driven gear bolt, if required.
12. Remove the balance shaft driven gear, if required.
13. Clean and inspect all of the components for wear and/or damage. Refer to **Timing Chain and Sprockets Cleaning and Inspection**.
14. If the pistons have been moved in the engine, use the following procedure:
  1. Turn the crankshaft so that the number one piston is at top dead center.
  2. Turn the camshaft so that, with the sprocket temporarily installed, the timing mark is straight down.

#### **Installation Procedure**



**Fig. 174: Balance Shaft Driven Gear & Bolt**  
Courtesy of GENERAL MOTORS CORP.

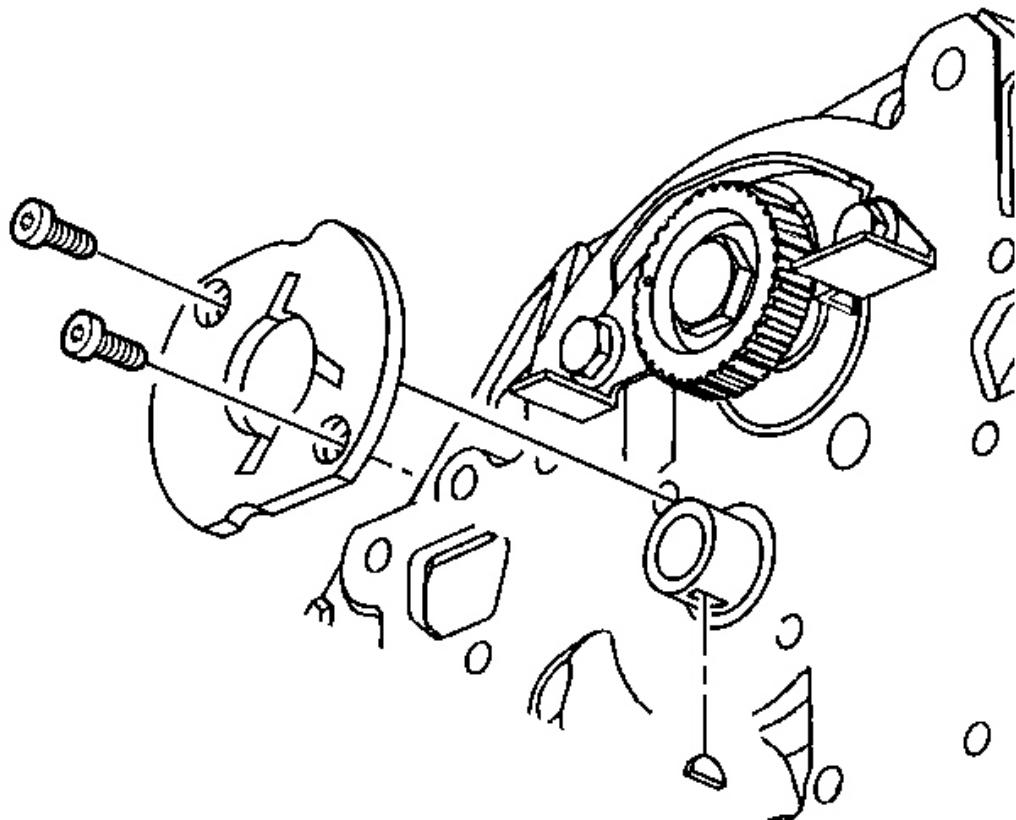
1. Install the balance shaft driven gear, if required.

**NOTE:** Refer to Fastener Notice .

**NOTE:** Refer to SPECIAL FASTENER NOTICE .+

2. Prevent the balance shaft from rotating and install the balance shaft driven gear bolt, if required.

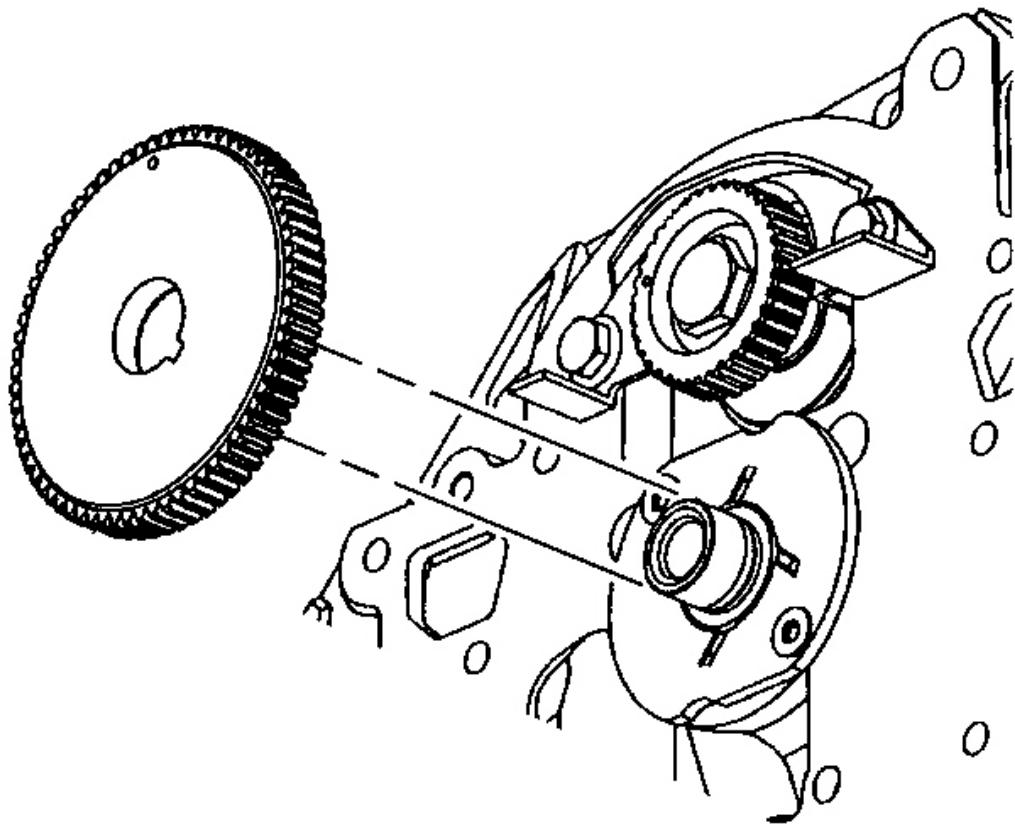
**Tighten:** Tighten the bolt to 22 N.m (16 lb ft) plus an additional 70 degrees using **J 45059** .  
See Special Tools.



**Fig. 175: Camshaft Thrust Plate & Bolts**  
Courtesy of GENERAL MOTORS CORP.

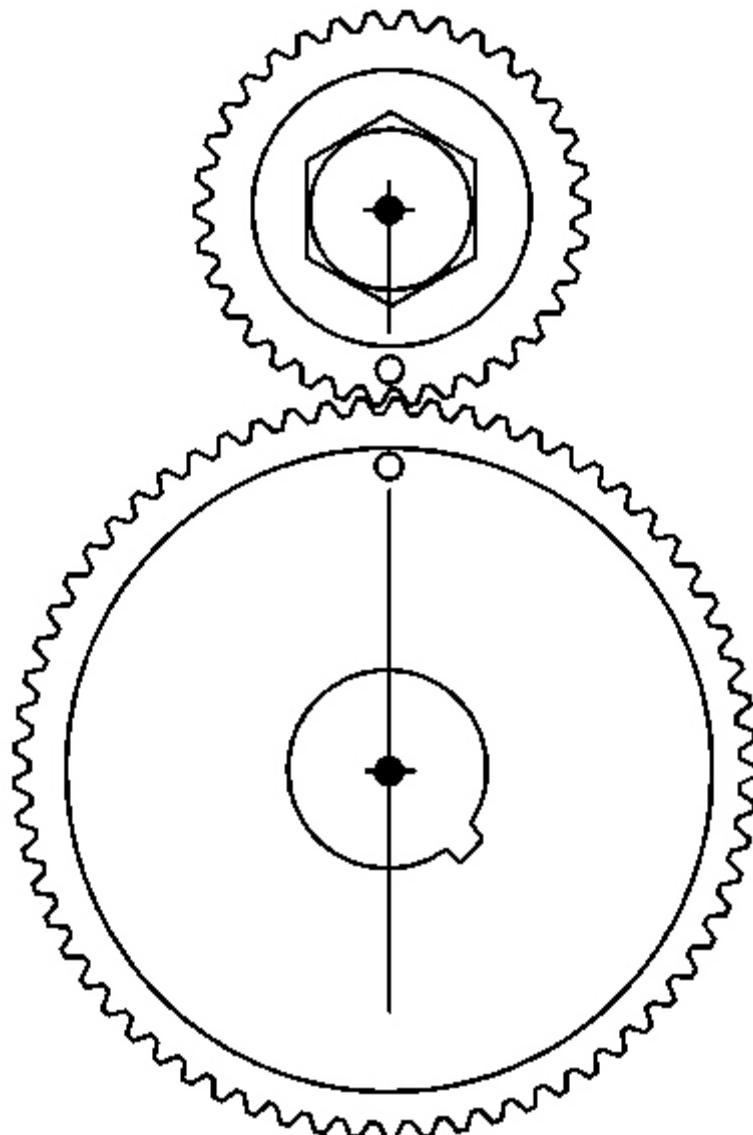
3. Install the camshaft thrust plate, if required.
4. Install the camshaft thrust plate bolts, if required.

**Tighten:** Tighten the bolts to 15 N.m (11 lb ft).



**Fig. 176: View Of Balance Shaft Drive Gear**  
Courtesy of GENERAL MOTORS CORP.

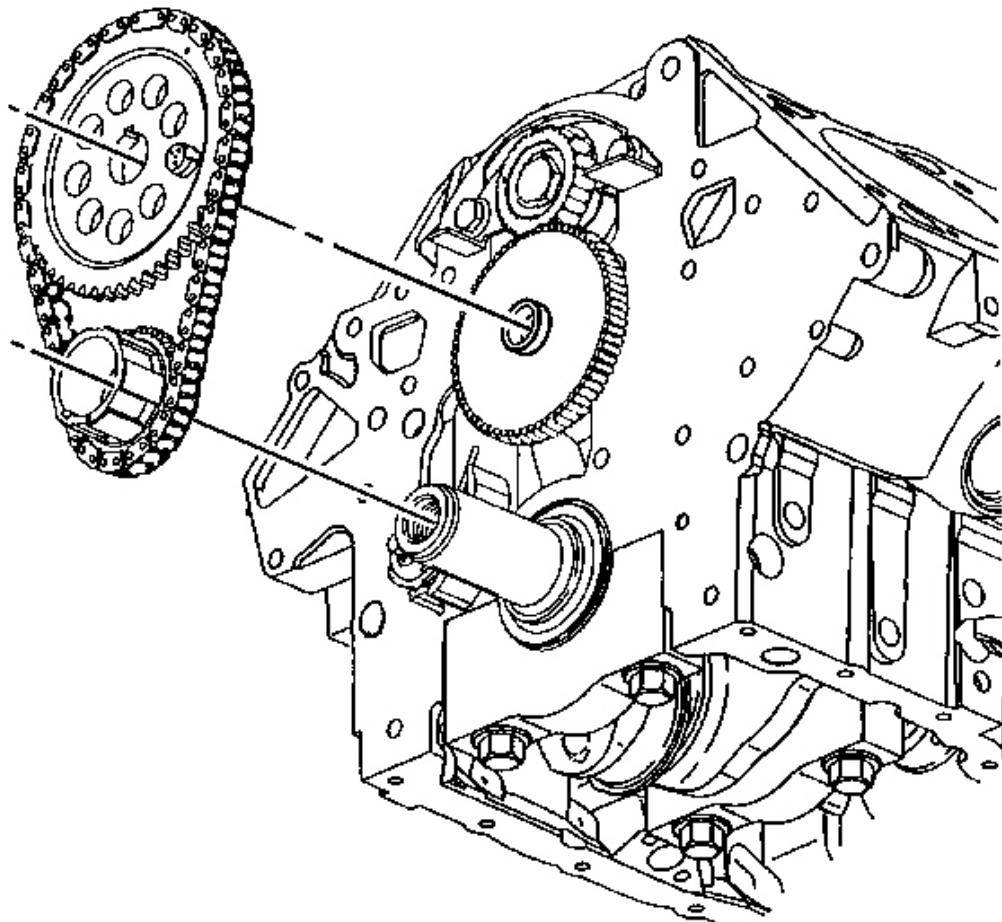
5. Install the balance shaft drive gear.



**Fig. 177: Identifying Balance Shaft Drive Gear & Balance Shaft Driven Gear Timing Marks**

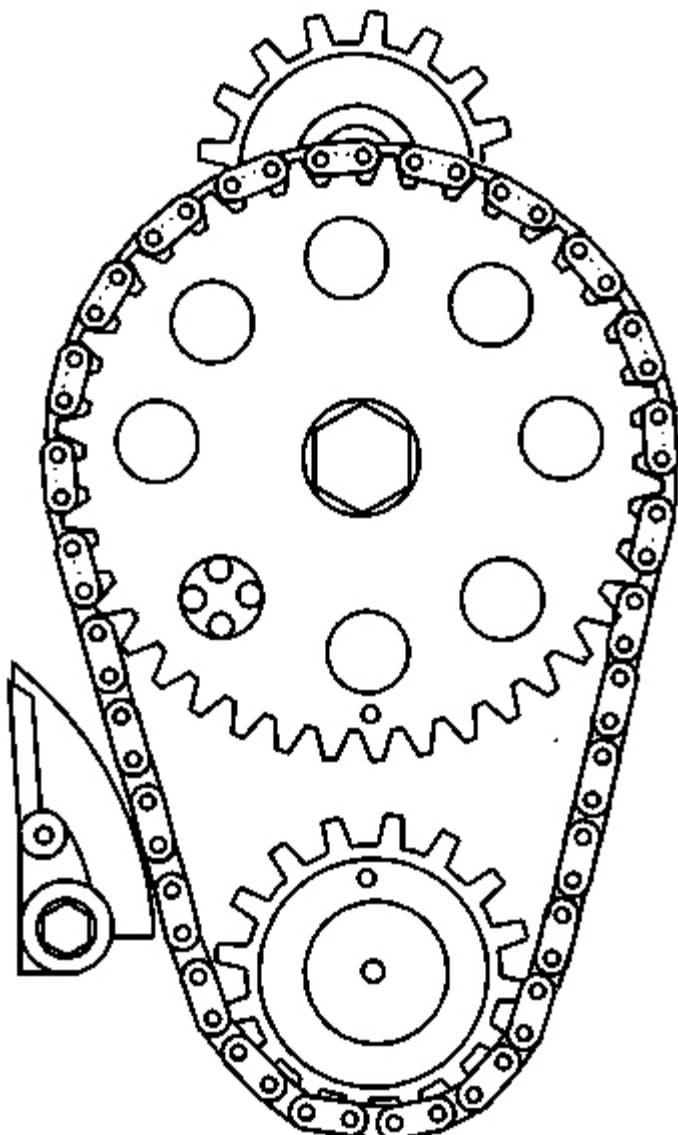
Courtesy of GENERAL MOTORS CORP.

6. Align the timing marks on the balance shaft drive gear and the balance shaft driven gear.



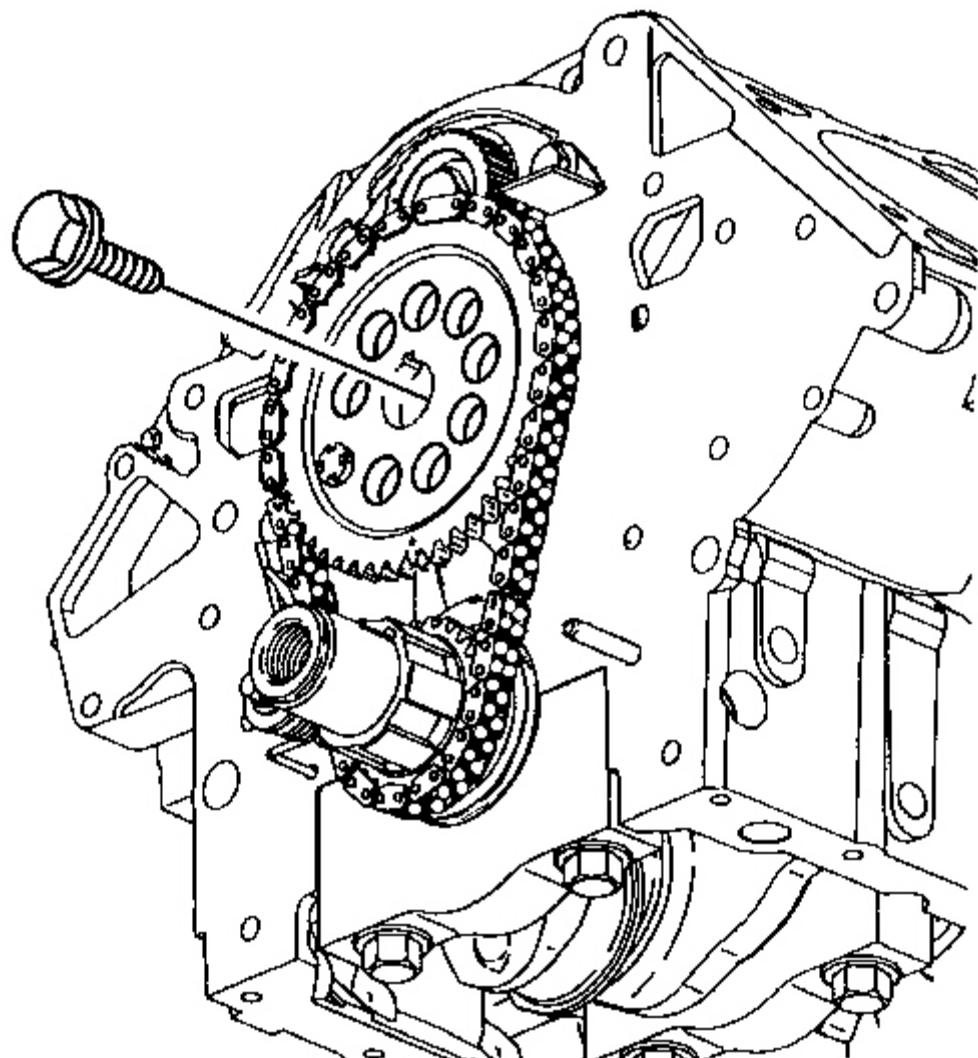
**Fig. 178: Locating Camshaft Sprocket & Timing Chain**  
Courtesy of GENERAL MOTORS CORP.

7. Install the crankshaft sprocket.
8. Install the timing chain and sprocket.



**Fig. 179: Aligning Timing Chain & Sprocket Timing Marks**  
Courtesy of GENERAL MOTORS CORP.

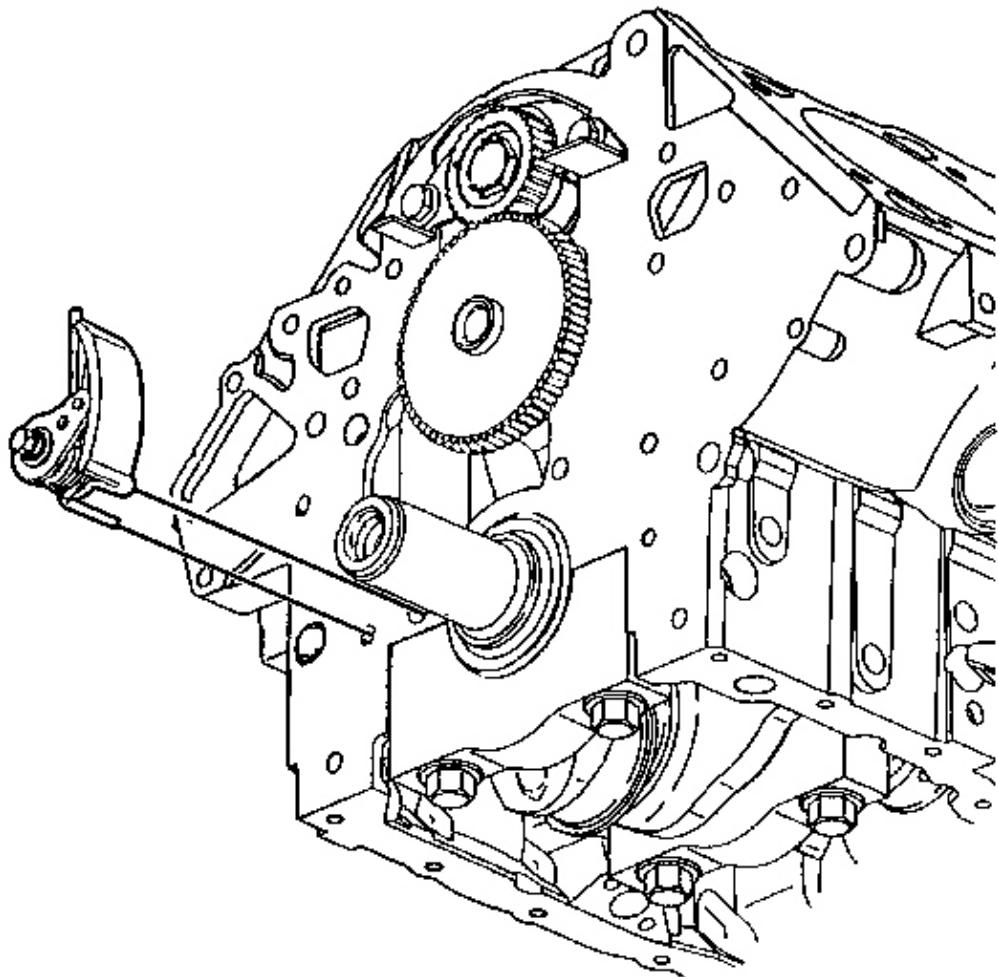
9. Assemble the timing chain on the sprockets with the timing marks as close together as possible.



**Fig. 180: Identifying Camshaft Sprocket Bolt**  
Courtesy of GENERAL MOTORS CORP.

10. Install the camshaft sprocket bolt.

**Tighten:** Tighten the bolt to 100 N.m (74 lb ft) plus an additional 90 degrees using **J 45059**. See Special Tools.



**Fig. 181: Identifying Timing Chain Dampener & Bolt**  
Courtesy of GENERAL MOTORS CORP.

11. Install the timing chain dampener.
12. Tighten the timing chain dampener bolt.

**Tighten:** Tighten the bolt to 22 N.m (16 lb ft).

**IMPORTANT:** Rotate the engine two revolutions and check the timing marks. Ensure that the marks are aligned.

13. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

### **CYLINDER HEAD REPLACEMENT - LEFT SIDE**

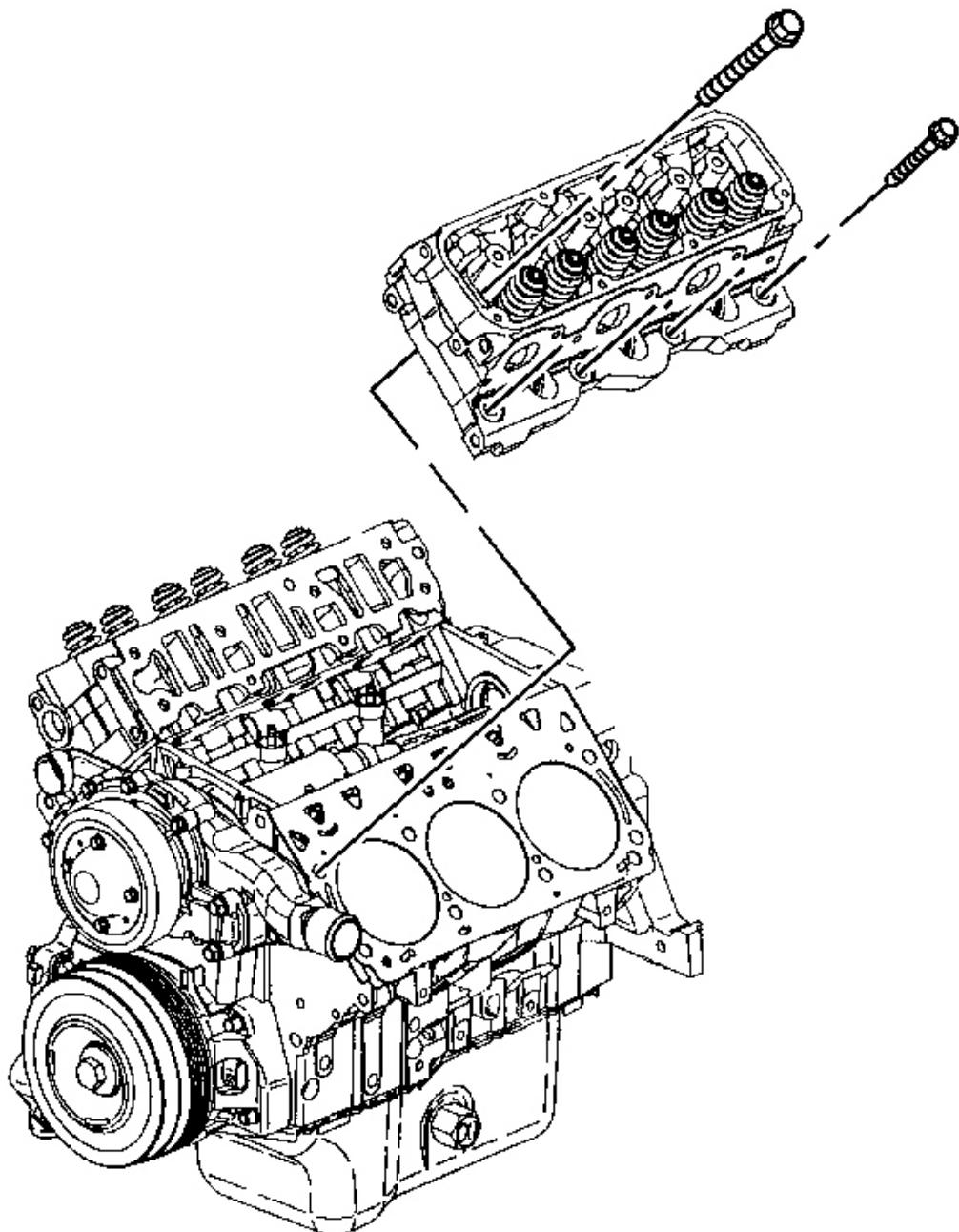
#### **Tools Required**

**J 45059** Angle Meter. See **Special Tools**.

#### **Removal Procedure**

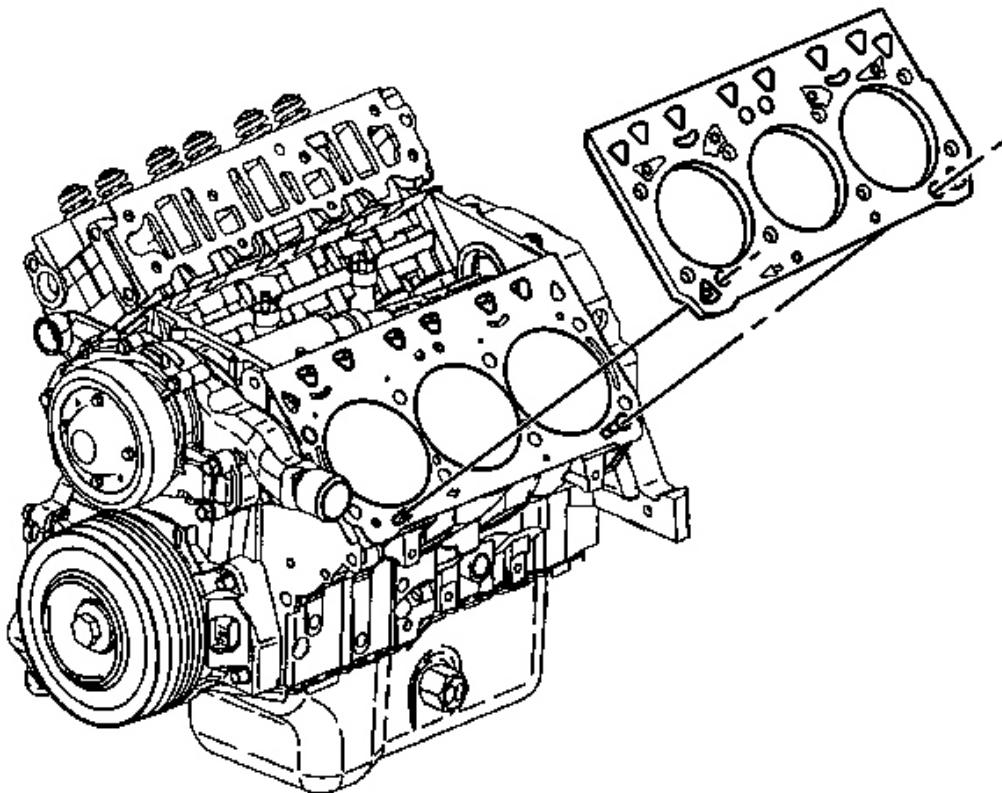
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**Fig. 182: Left Cylinder Head & Bolts**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the ignition control module and bracket. Refer to [Ignition Control Module Replacement](#).
2. Remove the lower intake manifold. Refer to [Lower Intake Manifold Replacement](#).
3. Remove the left push rods and rocker arms. Refer to [Valve Rocker Arm and Push Rod Replacement](#).
4. Remove the left exhaust manifold. Refer to [Exhaust Manifold Replacement - Left Side \(RPO L26\)](#) or [Exhaust Manifold Replacement - Left Side \(RPO LD8\)](#).
5. Remove and discard the cylinder head bolts.
6. Remove the cylinder head.



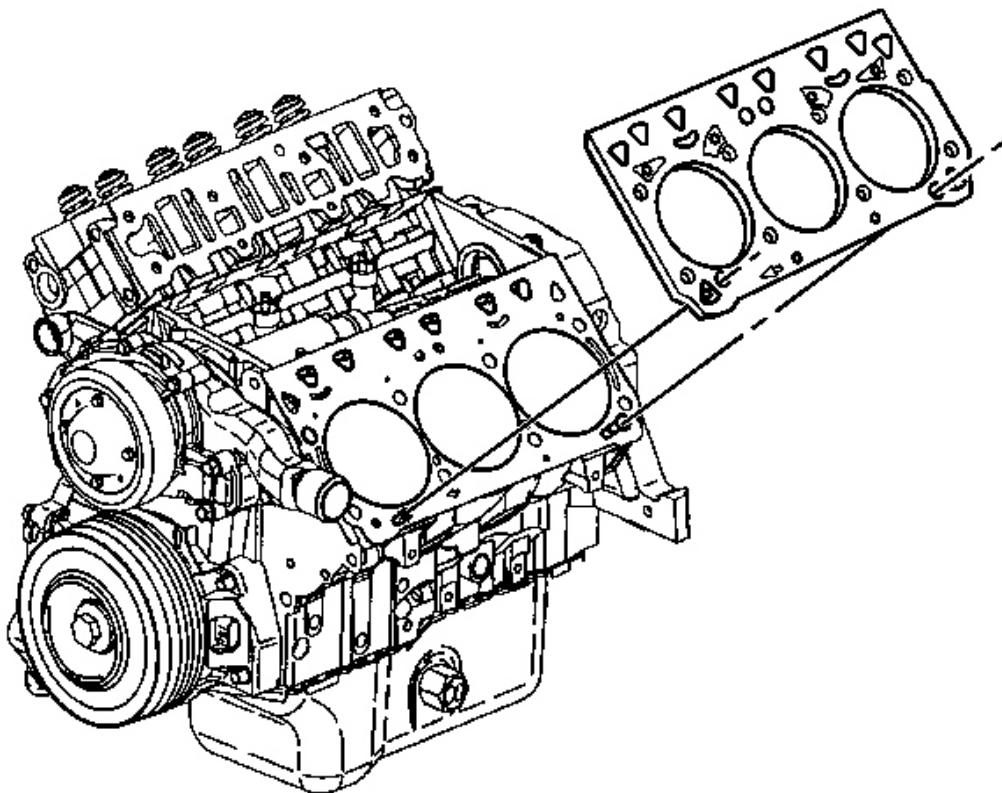
**Fig. 183: View Of Left Cylinder Head Gasket**  
Courtesy of GENERAL MOTORS CORP.

7. Remove the cylinder head gasket.

8. Remove the caps, springs, valves and seals from the cylinder head. Refer to [Cylinder Head Disassemble](#).
9. Inspect the engine block. Refer to [Engine Block Cleaning and Inspection](#).
10. Inspect the cylinder head. Refer to [Cylinder Head Cleaning and Inspection](#).
11. Clean the gasket mating surfaces on the cylinder head, the cylinder block and the intake manifold.
12. Clean the cylinder block bolt hole threads.

**Installation Procedure**

**NOTE:** **Head gaskets are not interchangeable. The head gasket must be installed with the arrow pointing to the front of the engine. Installing the head gasket in any other direction will cause gasket failure and possible engine failure.**



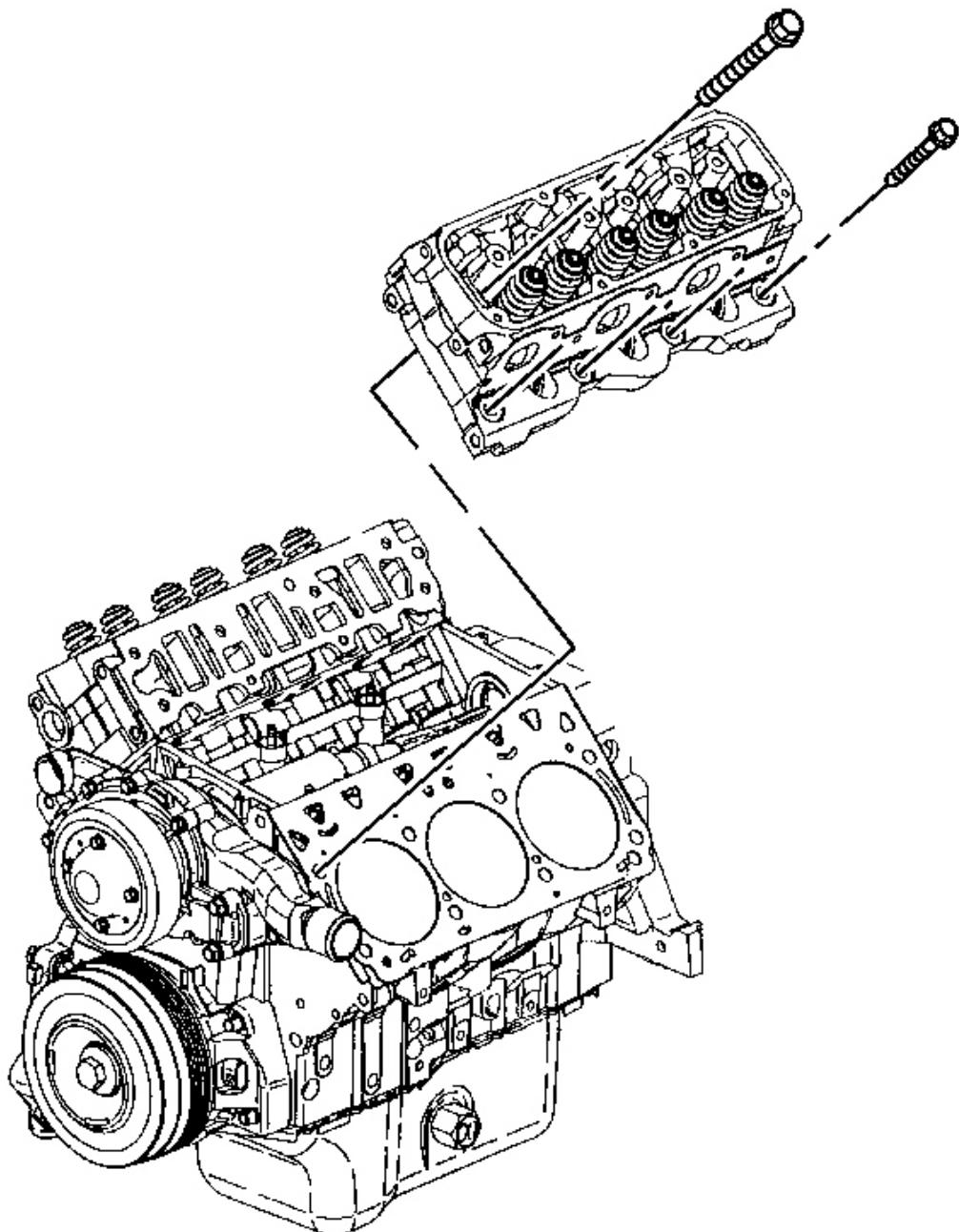
**Fig. 184: View Of Left Cylinder Head Gasket**

Courtesy of GENERAL MOTORS CORP.

1. Install the valves, seals, springs and the caps to the cylinder head. Refer to [Cylinder Head Assemble](#).
2. Position the head gasket with the arrow pointing to the front of the engine.

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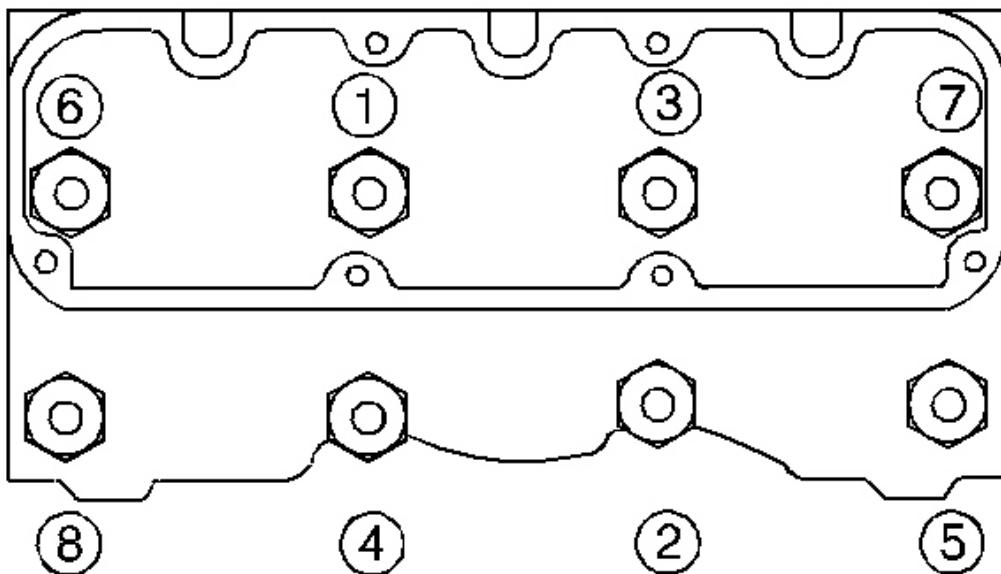


**Fig. 185: Left Cylinder Head & Bolts**  
Courtesy of GENERAL MOTORS CORP.

3. Install the cylinder head.

**NOTE:** This bolt is designed to permanently stretch when tightened and therefore **MUST** be replaced anytime it is removed. The correct part number fastener must be used to replace this type of fastener. Do not use a bolt that is stronger in this application. If the correct bolt is not used, the parts will not be tightened correctly. The system or the components may be damaged.

**NOTE:** This engine uses special torque to yield head bolts. This design bolt requires a special tightening procedure. Failure to follow the given procedure will cause head gasket failure and possible engine damage.



**Fig. 186: Identifying Cylinder Head Bolt Tightening Sequence**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Refer to Fastener Notice .

4. Install NEW cylinder head bolts (1-8).

**Tighten:** Tighten the bolts in the sequence shown to 50 N.m (37 lb ft) plus an additional 120 degrees using **J 45059** . See Special Tools.

5. Install the left exhaust manifold. Refer to Exhaust Manifold Replacement - Left Side (RPO L26) or Exhaust Manifold Replacement - Left Side (RPO LD8) .
6. Install the left push rods and rocker arms. Refer to Valve Rocker Arm and Push Rod Replacement.
7. Install the lower intake manifold. Refer to Lower Intake Manifold Replacement.
8. Install the ignition control module and bracket. Refer to Ignition Control Module Replacement .
9. Inspect for leaks.

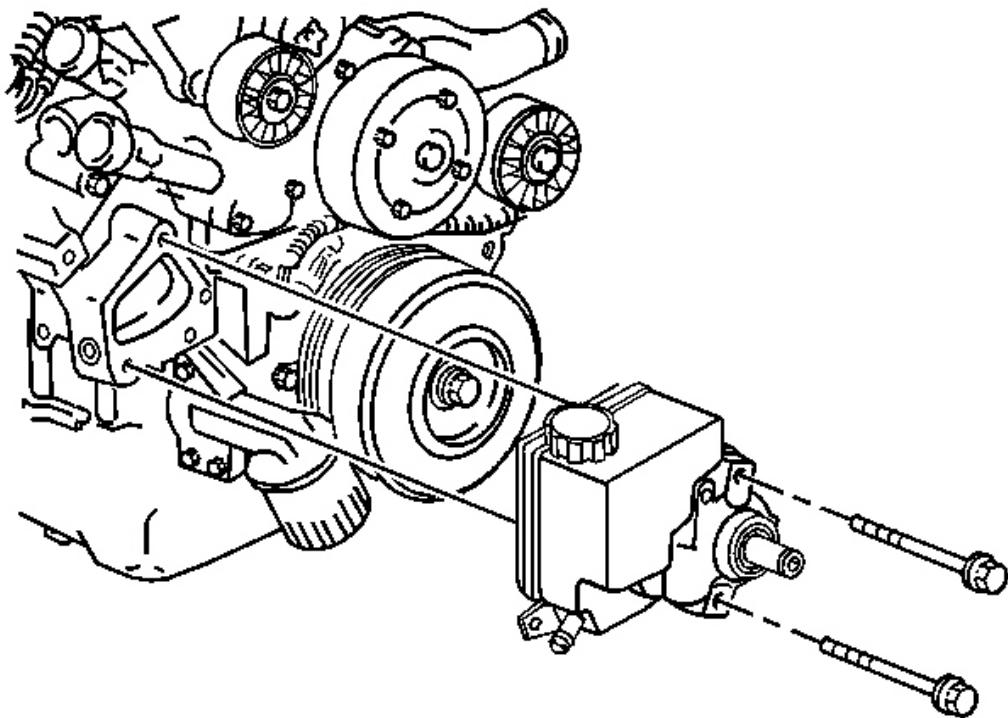
## **CYLINDER HEAD REPLACEMENT - RIGHT SIDE**

### **Tools Required**

**J 45059** Angle Meter. See Special Tools.

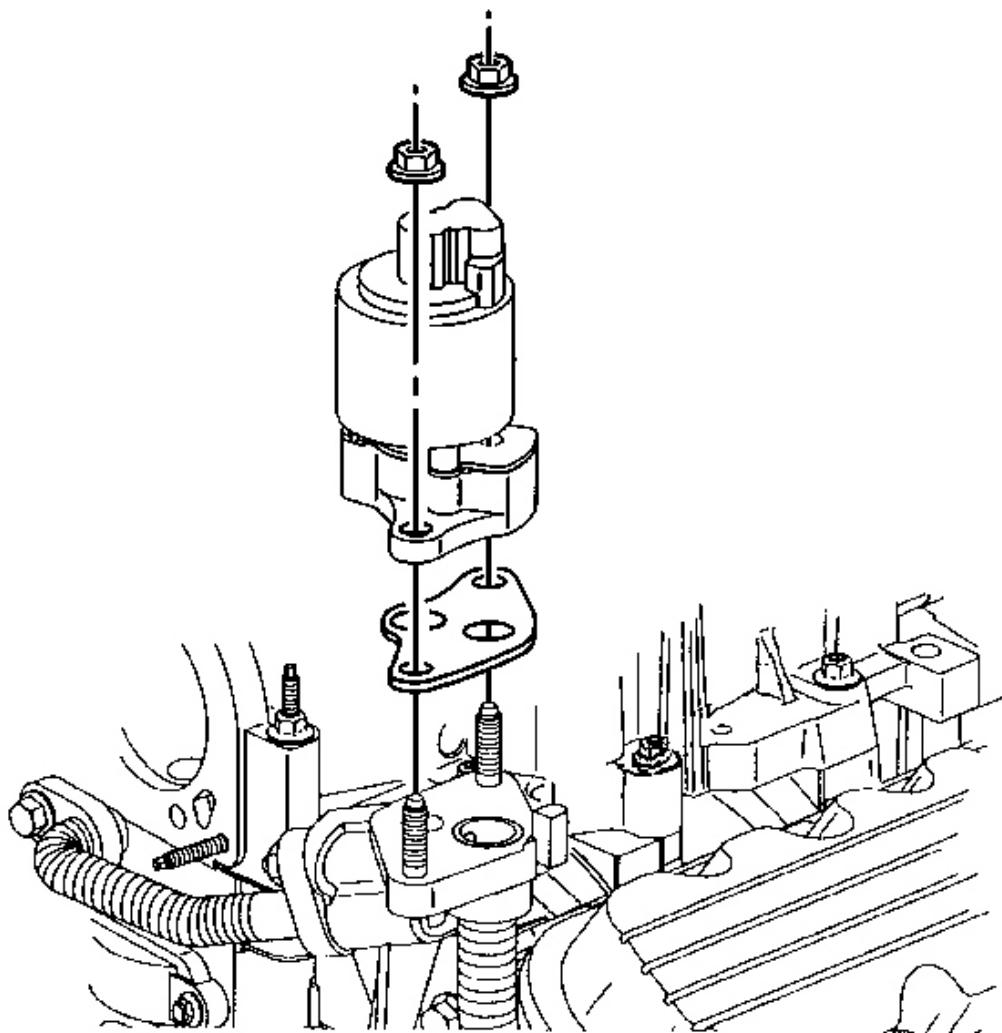
### **Removal Procedure**

1. Remove the lower intake manifold. Refer to Lower Intake Manifold Replacement.



**Fig. 187: View Of Power Steering Pump And Mounting Bolts**  
Courtesy of GENERAL MOTORS CORP.

2. Remove the power steering pump bolts and reposition the power steering pump.
3. Remove the right exhaust manifold. Refer to [Exhaust Manifold Replacement - Right Side \(RPO L26\)](#) or [Exhaust Manifold Replacement - Right Side \(RPO LD8\)](#) .
4. Remove the right rocker arms and push rods. Refer to [Valve Rocker Arm and Push Rod Replacement](#).

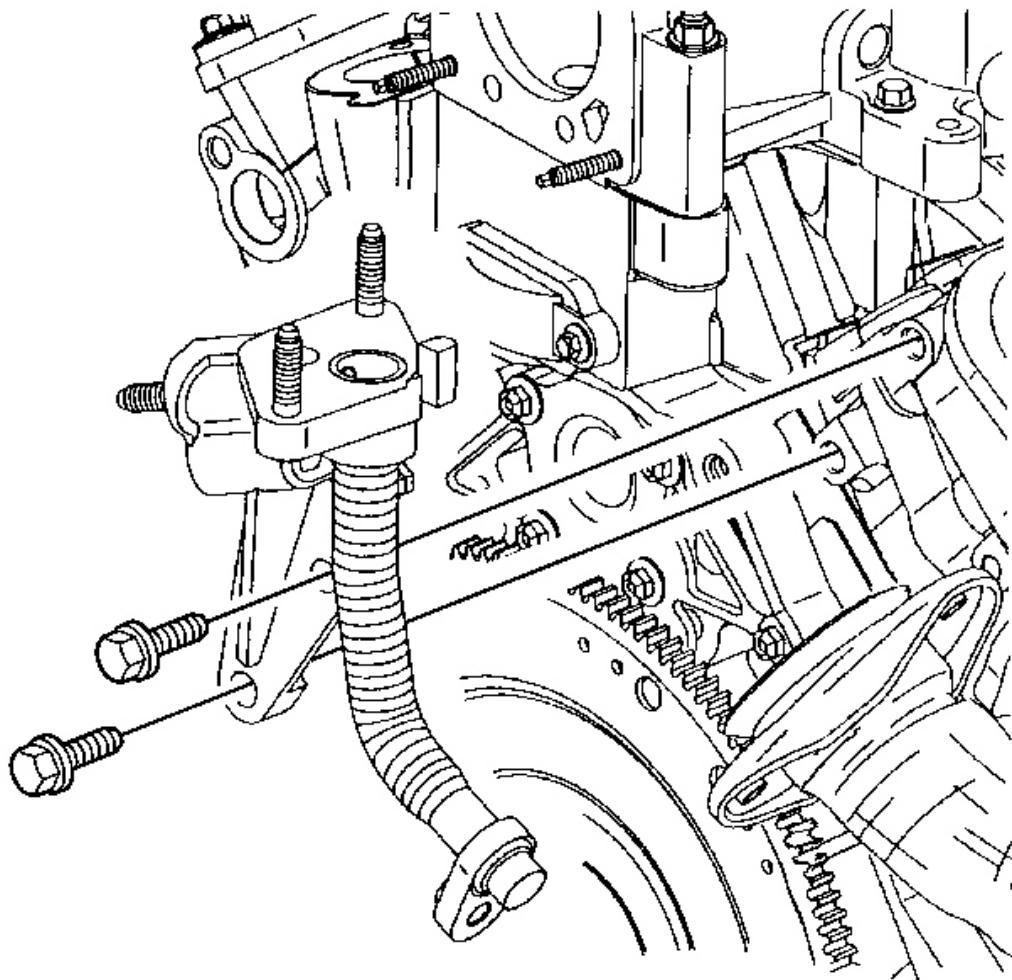


**Fig. 188: Identifying EGR Valve & Nuts**  
Courtesy of GENERAL MOTORS CORP.

5. Remove the exhaust gas recirculation (EGR) valve nuts.
6. Remove the EGR valve.

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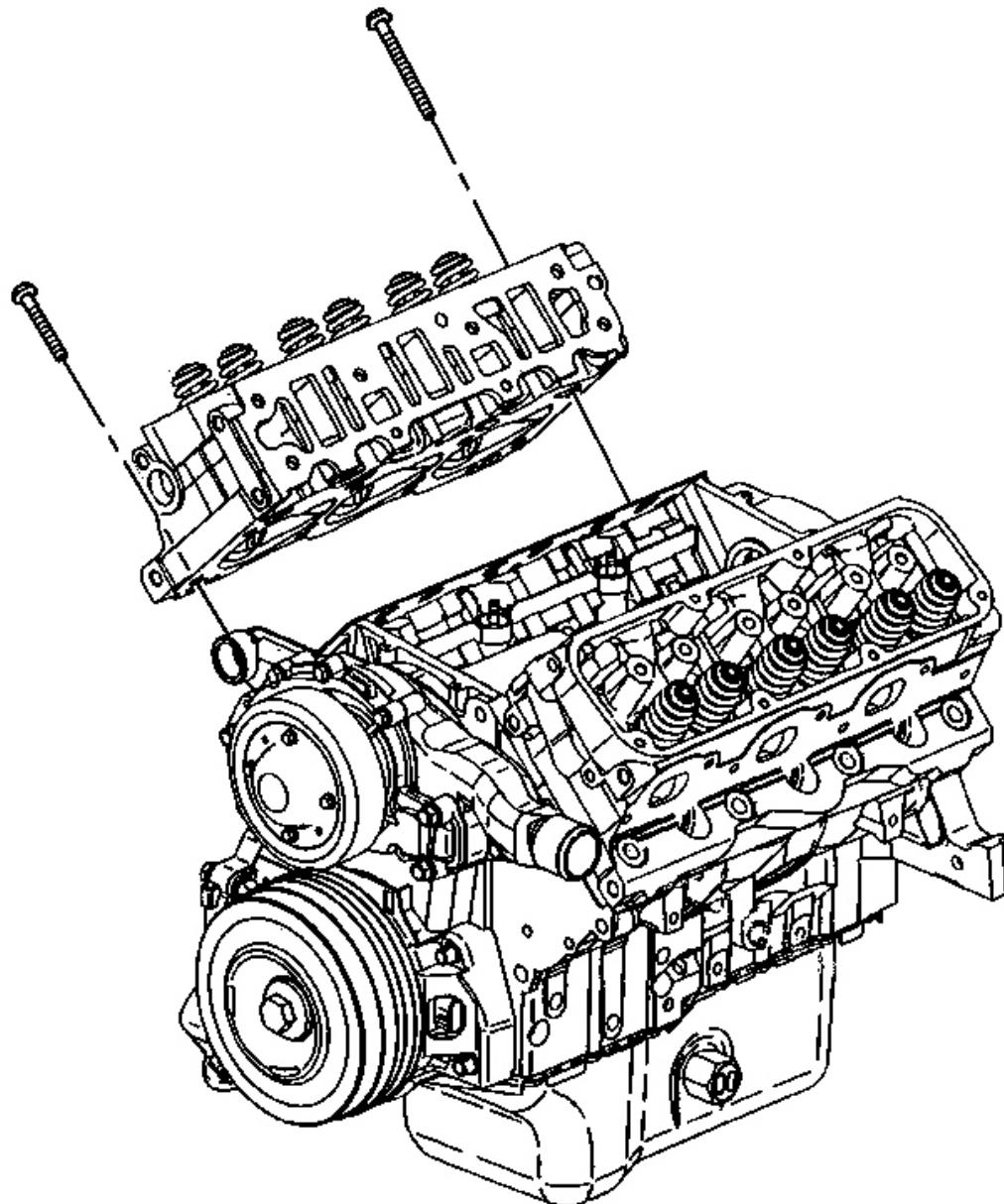


**Fig. 189: EGR Valve Adapter & Bolts**  
Courtesy of GENERAL MOTORS CORP.

7. Remove the EGR valve adapter bolts.
8. Remove the EGR valve adapter.

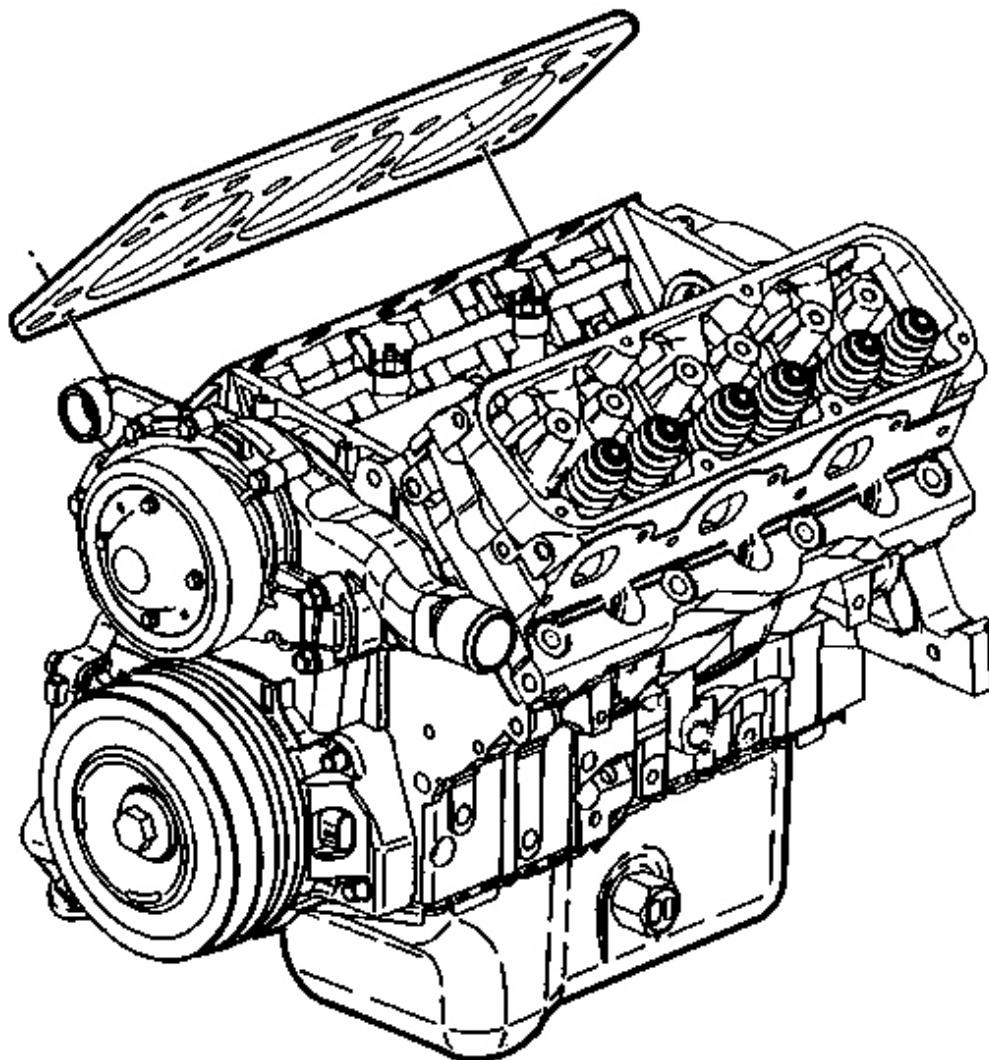
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**Fig. 190: Right Cylinder Head & Bolts**  
Courtesy of GENERAL MOTORS CORP.

9. Remove and discard the cylinder head bolts.
10. Remove the right cylinder head.



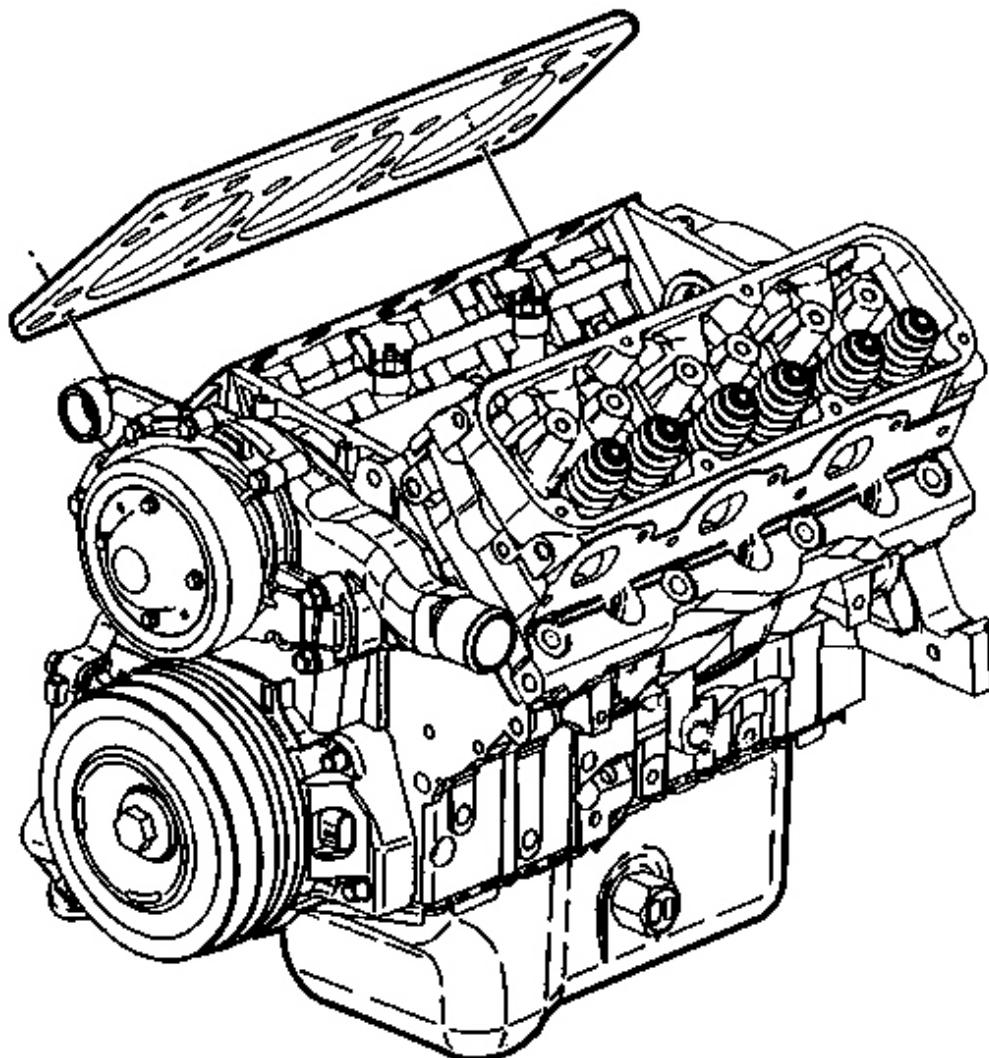
**Fig. 191: View Of Right Cylinder Head Gasket**  
Courtesy of GENERAL MOTORS CORP.

11. Remove the cylinder head gasket.
12. Remove the caps, springs, valves and seals from the cylinder head. Refer to [Cylinder Head Disassemble](#).
13. Inspect the engine block. Refer to [Engine Block Cleaning and Inspection](#).

14. Inspect the cylinder head. Refer to [Cylinder Head Cleaning and Inspection](#).
15. Clean the gasket mating surfaces on the cylinder head, the engine block and the intake manifold.
16. Clean the cylinder block bolt hole threads.

**Installation Procedure**

**NOTE:** **Head gaskets are not interchangeable. The head gasket must be installed with the arrow pointing to the front of the engine. Installing the head gasket in any other direction will cause gasket failure and possible engine failure.**

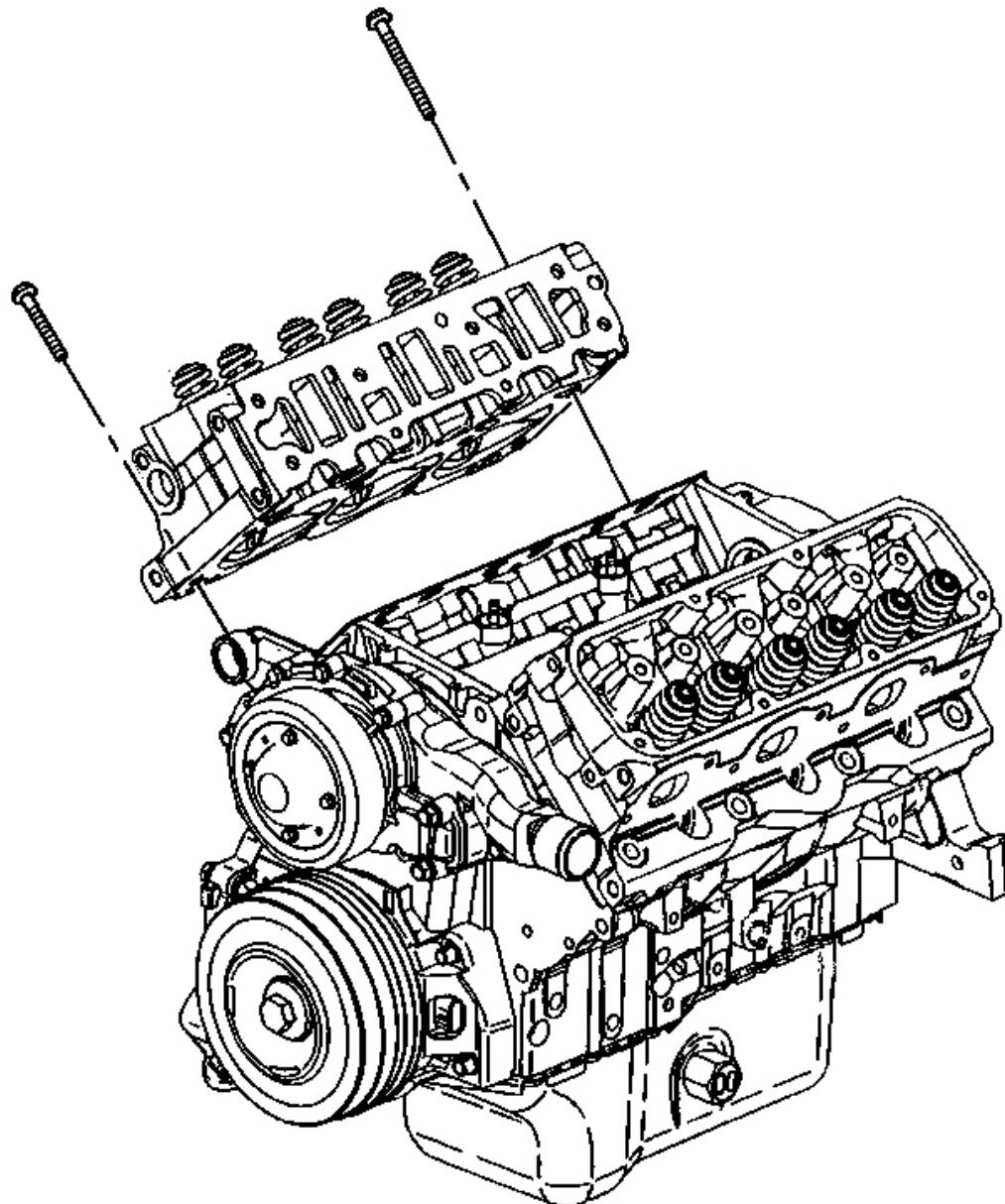


**Fig. 192: View Of Right Cylinder Head Gasket**  
Courtesy of GENERAL MOTORS CORP.

1. Install the valves, seals, springs and caps to the cylinder head. Refer to **Cylinder Head Assemble**.
2. Position the head gasket with the arrow pointing to the front of the engine.

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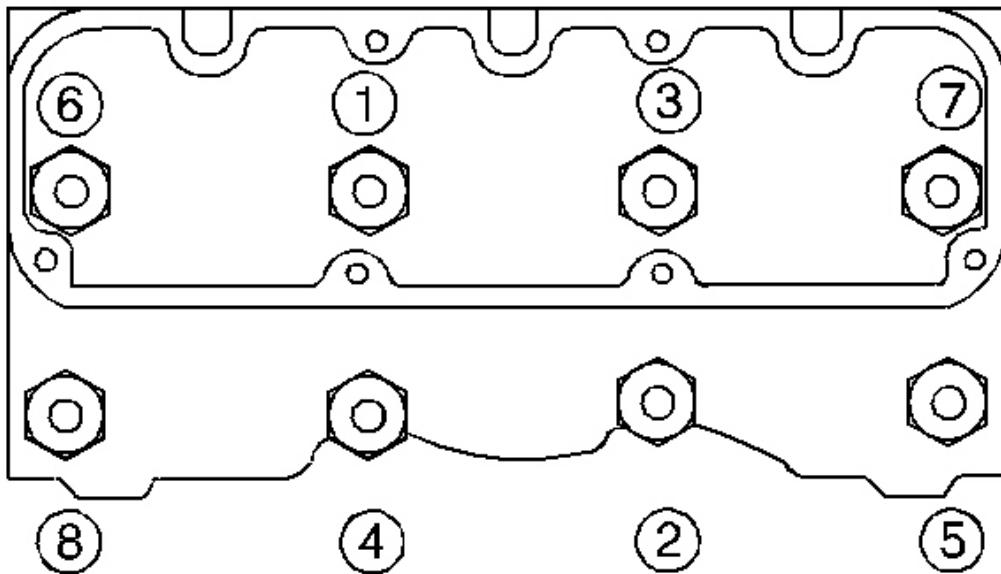


**Fig. 193: Right Cylinder Head & Bolts**  
Courtesy of GENERAL MOTORS CORP.

3. Install the cylinder head.

**NOTE:** This bolt is designed to permanently stretch when tightened and therefore **MUST** be replaced anytime it is removed. The correct part number fastener must be used to replace this type of fastener. Do not use a bolt that is stronger in this application. If the correct bolt is not used, the parts will not be tightened correctly. The system or the components may be damaged.

**NOTE:** This engine uses special torque to yield head bolts. This design bolt requires a special tightening procedure. Failure to follow the given procedure will cause head gasket failure and possible engine damage.

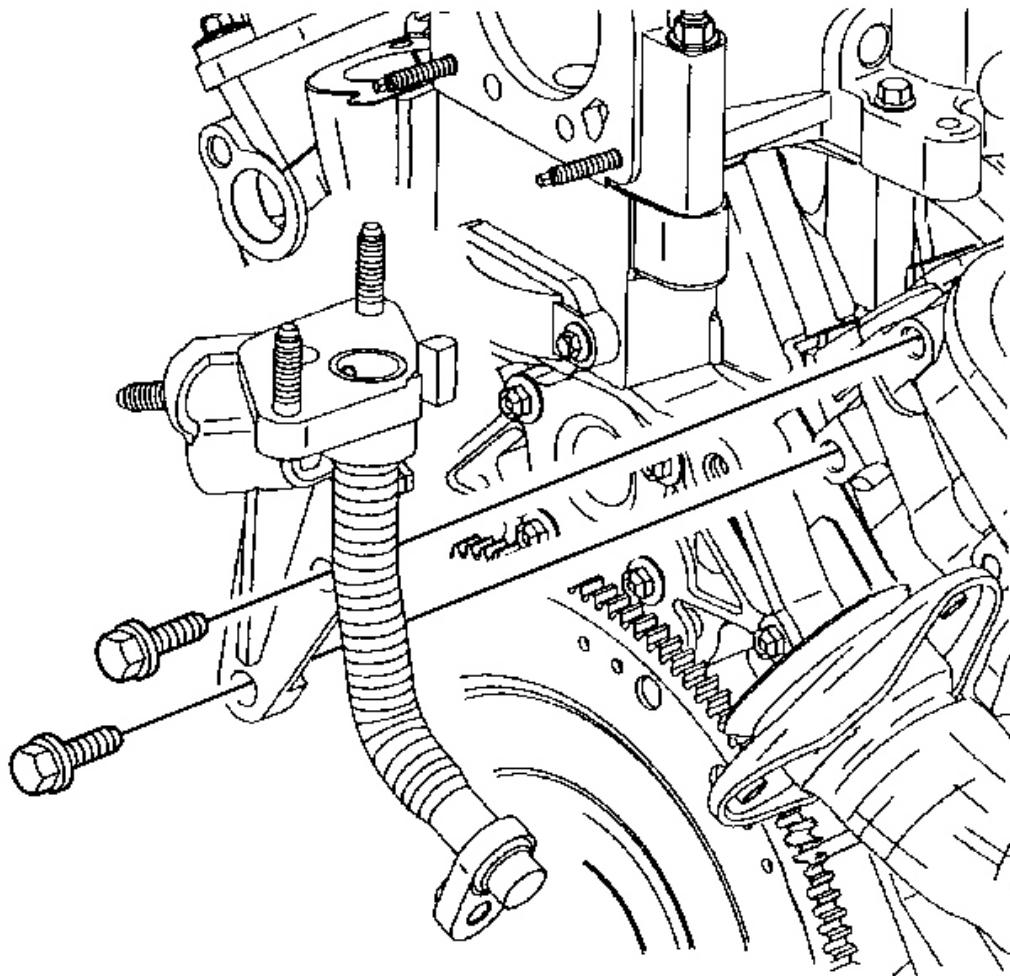


**Fig. 194: Identifying Cylinder Head Bolt Tightening Sequence**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Refer to Fastener Notice .

4. Install NEW cylinder head bolts (1-8).

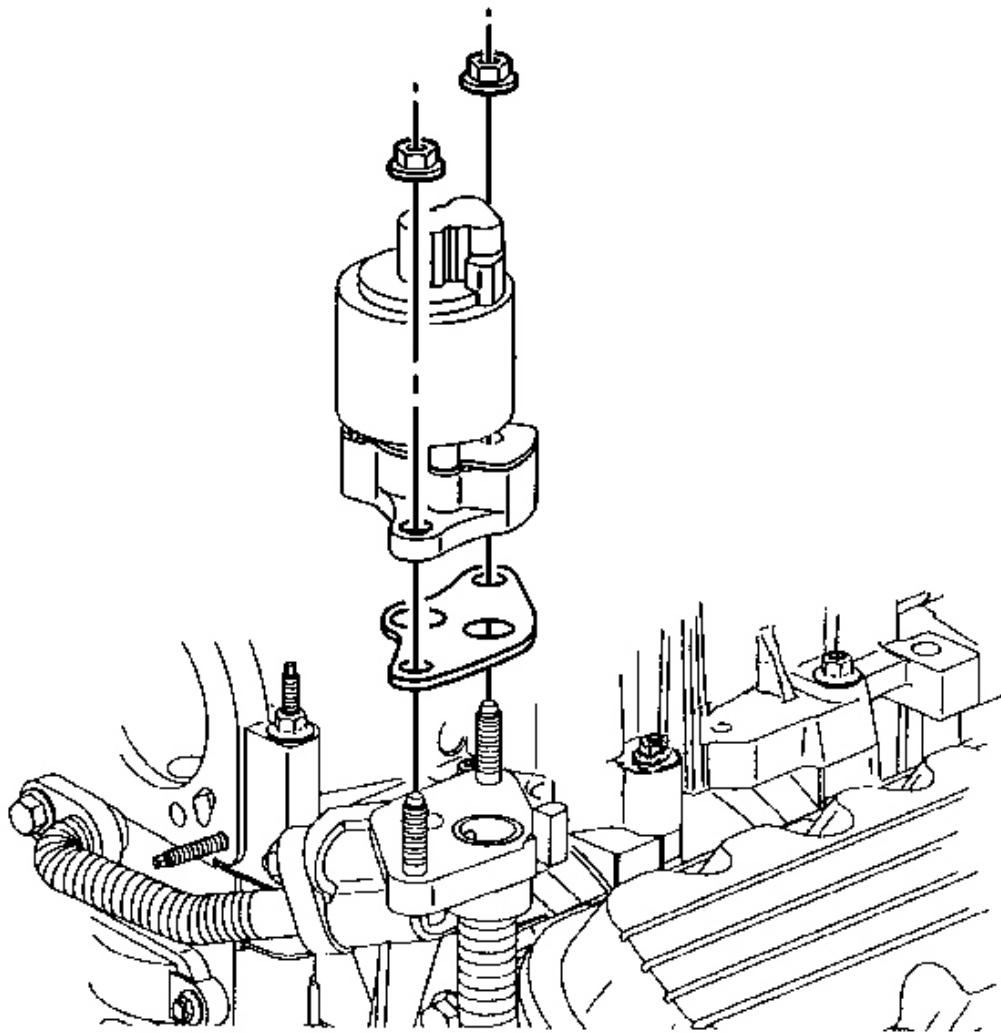
**Tighten:** Tighten the bolts in the sequence shown to 50 N.m (37 lb ft) plus an additional 120 degrees using **J 45059** . See **Special Tools**.



**Fig. 195: EGR Valve Adapter & Bolts**  
Courtesy of GENERAL MOTORS CORP.

5. Install the EGR valve adapter to the right cylinder head.
6. Install the EGR valve adapter bolts to the right cylinder head.

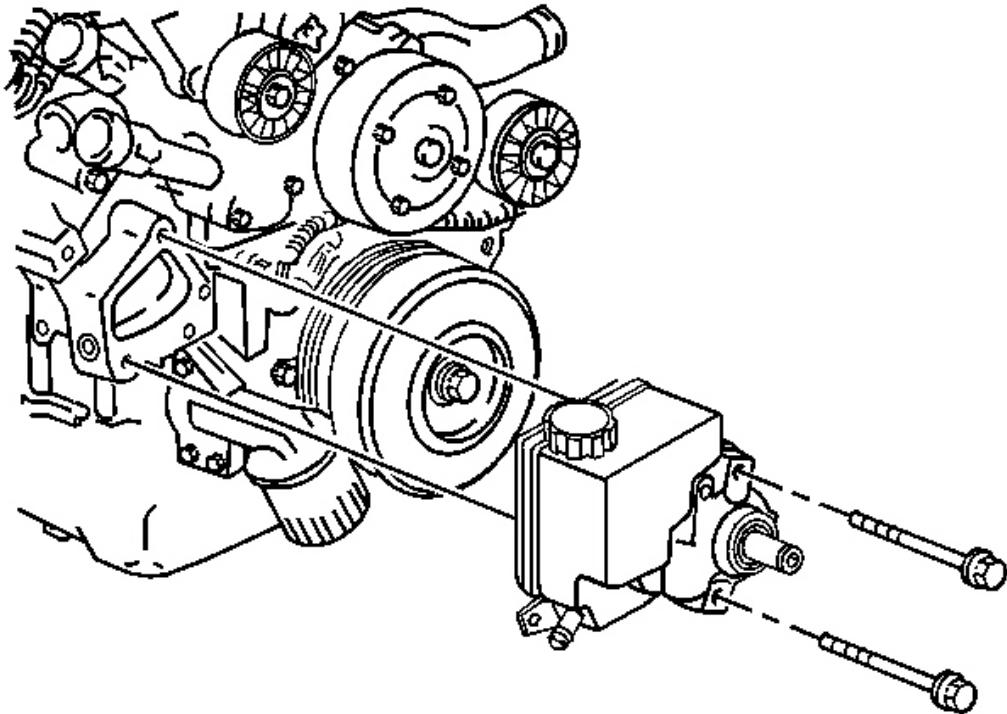
**Tighten:** Tighten the bolts to 50 N.m (37 lb ft).



**Fig. 196: Identifying EGR Valve & Nuts**  
Courtesy of GENERAL MOTORS CORP.

7. Install the EGR valve.
8. Install the EGR valve nuts.

**Tighten:** Tighten the nuts to 29 N.m (21 lb ft).



**Fig. 197: View Of Power Steering Pump And Mounting Bolts**  
Courtesy of GENERAL MOTORS CORP.

9. Install the right rocker arms and push rods. Refer to [Valve Rocker Arm and Push Rod Replacement](#).
10. Install the right exhaust manifold. Refer to [Exhaust Manifold Replacement - Right Side \(RPO L26\)](#) or [Exhaust Manifold Replacement - Right Side \(RPO LD8\)](#).
11. Position and install the power steering pump and bolts.

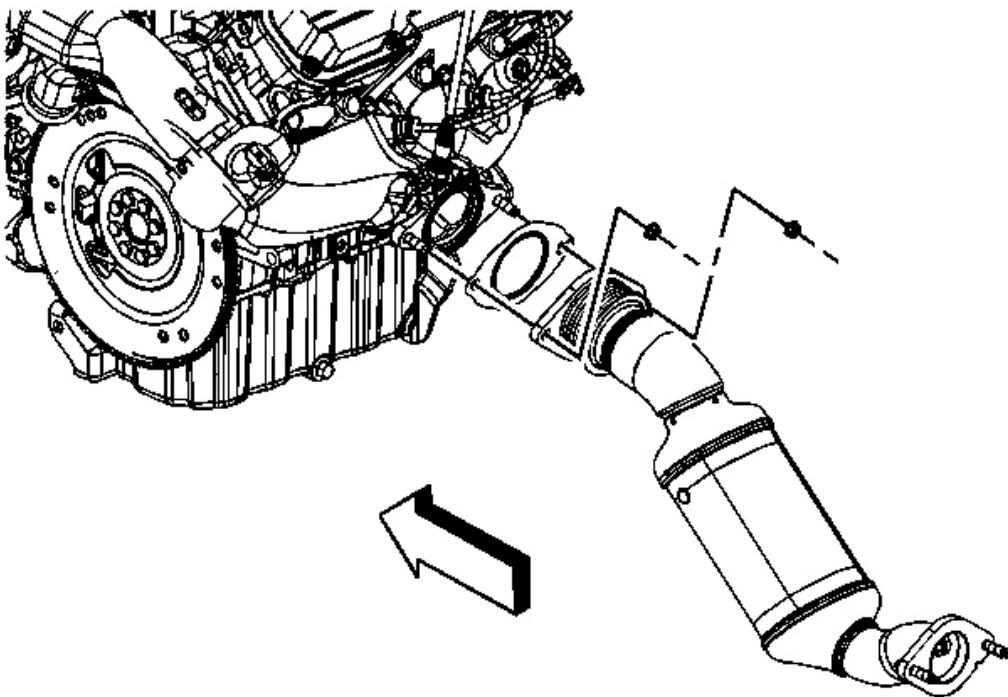
**Tighten:** Tighten the bolts to 34 N.m (25 lb ft).

12. Install the lower intake manifold. Refer to [Lower Intake Manifold Replacement](#).

## OIL PAN REPLACEMENT

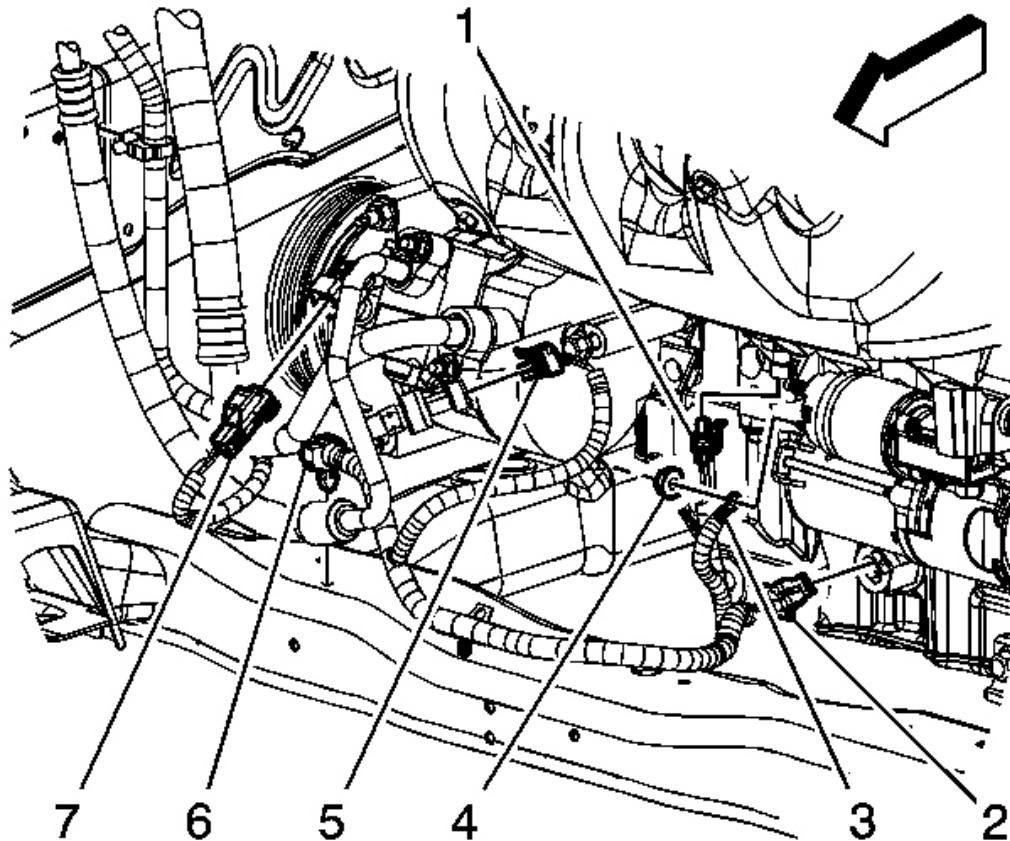
### Removal Procedure

1. Install the engine support fixture. Refer to [Engine Support Fixture](#).
2. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
3. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).



**Fig. 198: View Of Catalytic Converter-To-Exhaust Manifold Nuts**  
Courtesy of GENERAL MOTORS CORP.

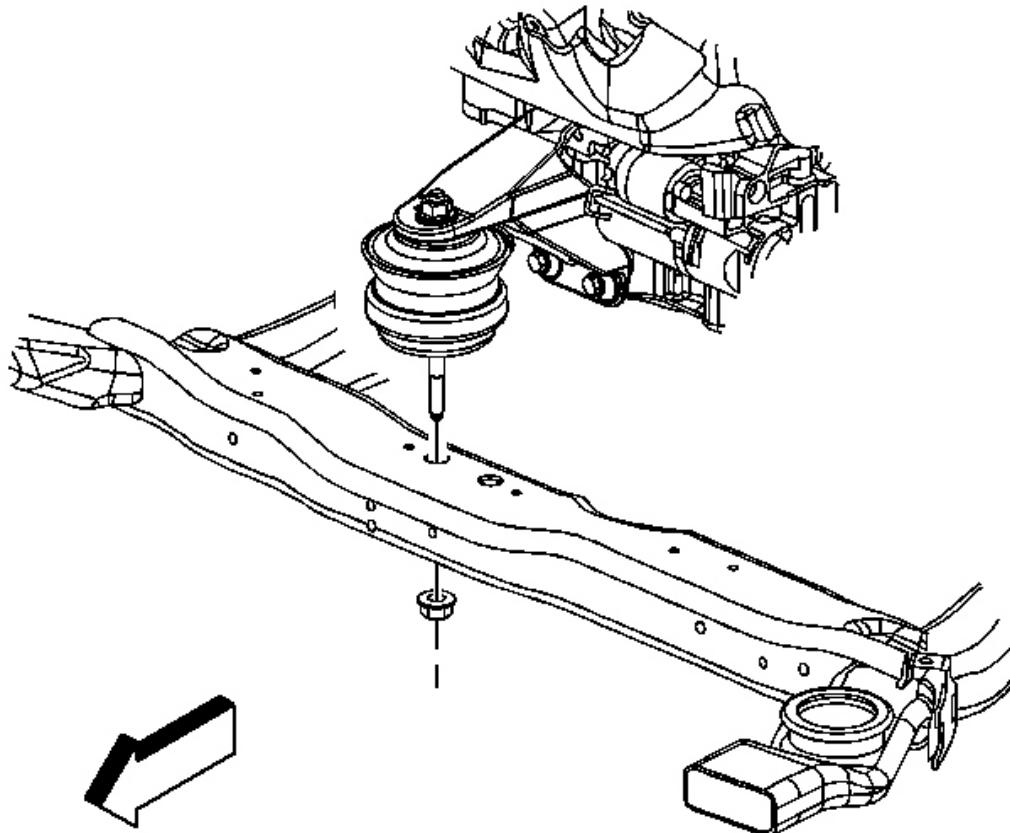
4. Remove the catalytic converter to exhaust manifold nuts.
5. Drain the engine oil and remove the oil filter. Refer to [Engine Oil and Oil Filter Replacement](#).



**Fig. 199: View Of Engine Harness Electrical Connectors**

Courtesy of GENERAL MOTORS CORP.

6. Disconnect the engine harness electrical connector (2) from the oil level sensor.

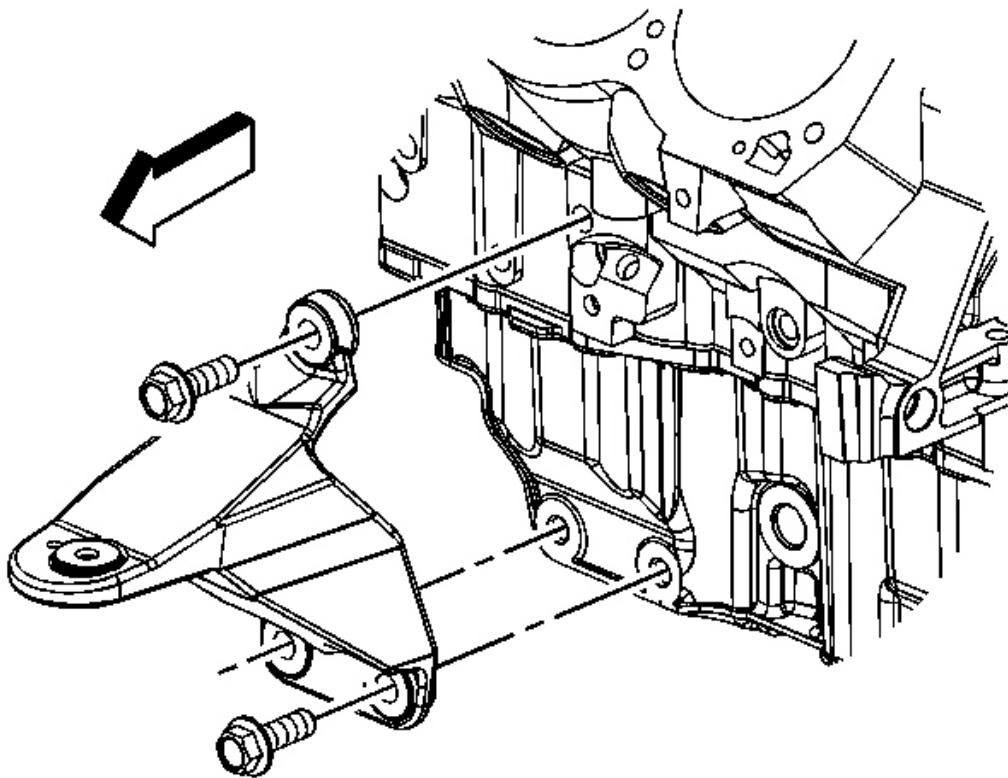


**Fig. 200: Identifying Engine Front Mount To Frame Nut**  
Courtesy of GENERAL MOTORS CORP.

7. Remove the front engine mount to frame nut.
8. Lower the vehicle.
9. Using the engine support fixture, raise the engine.
10. Raise the vehicle.

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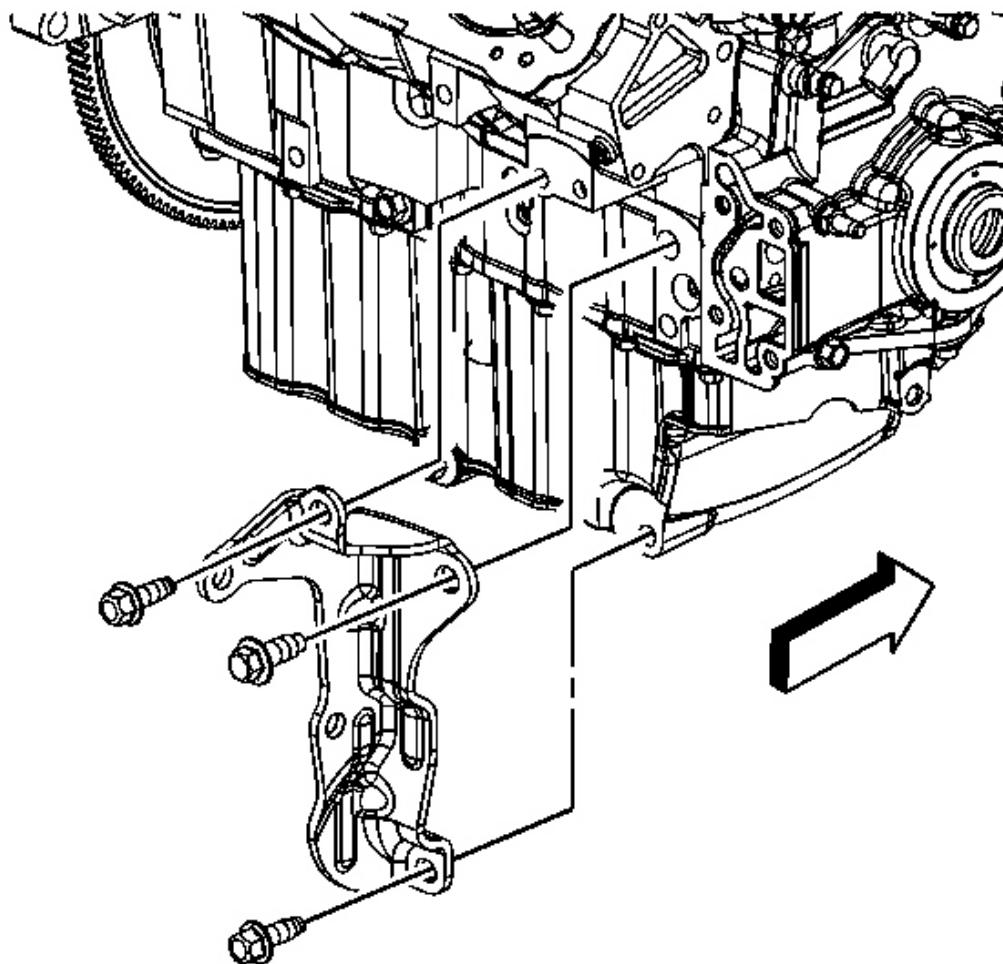
**Fig. 201: View Of Engine Mount Bracket & Bolts**

Courtesy of GENERAL MOTORS CORP.

11. Remove the front engine mount bracket bolts.
12. Remove the front engine mount bracket with mount.

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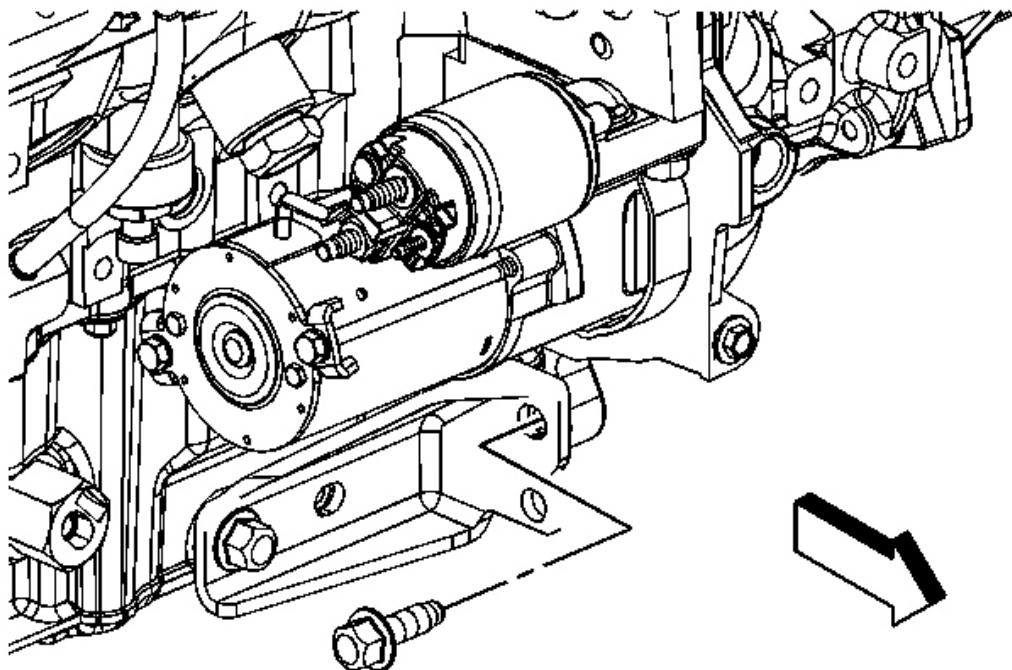
2006 ENGINE Engine Mechanical - 3.8L - Lucerne



**Fig. 202: Identifying Transaxle Brace-To-Oil Pan & Bolts**

Courtesy of GENERAL MOTORS CORP.

13. Remove the transaxle brace to oil pan bolt.

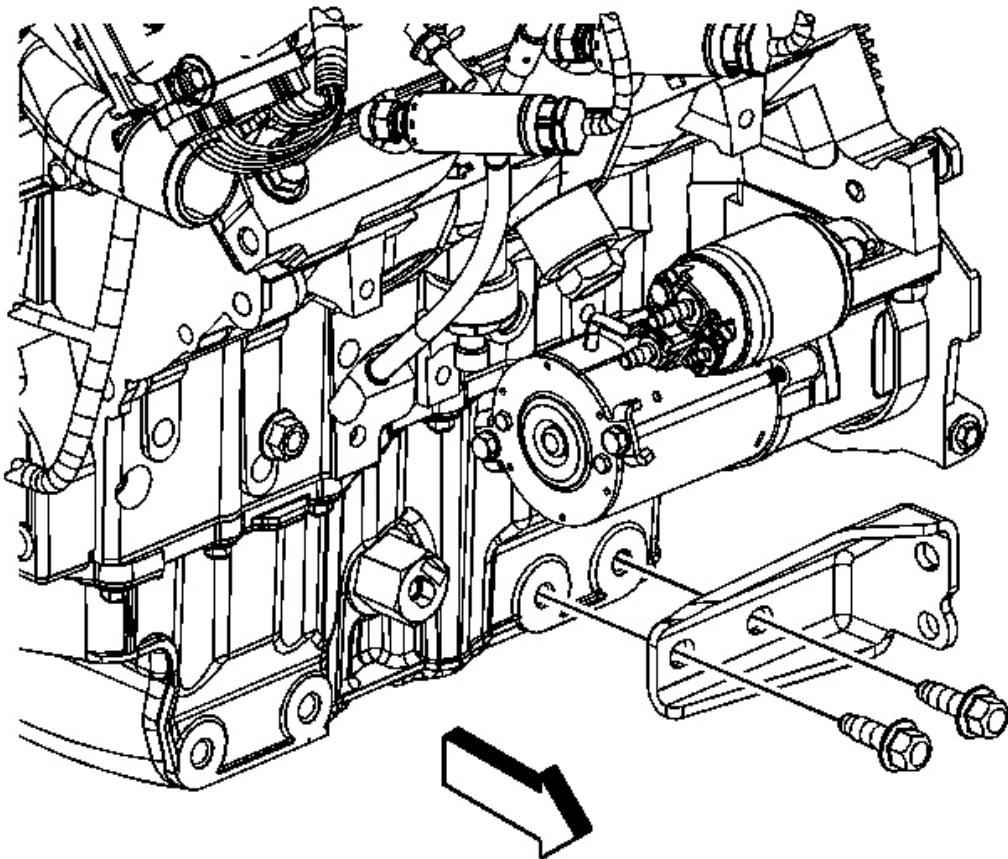


**Fig. 203: Identifying Transaxle Brace-To-Transaxle & Bolts**  
Courtesy of GENERAL MOTORS CORP.

14. Remove the transaxle brace to transaxle bolts.
15. Remove the transaxle brace to oil pan bolts.

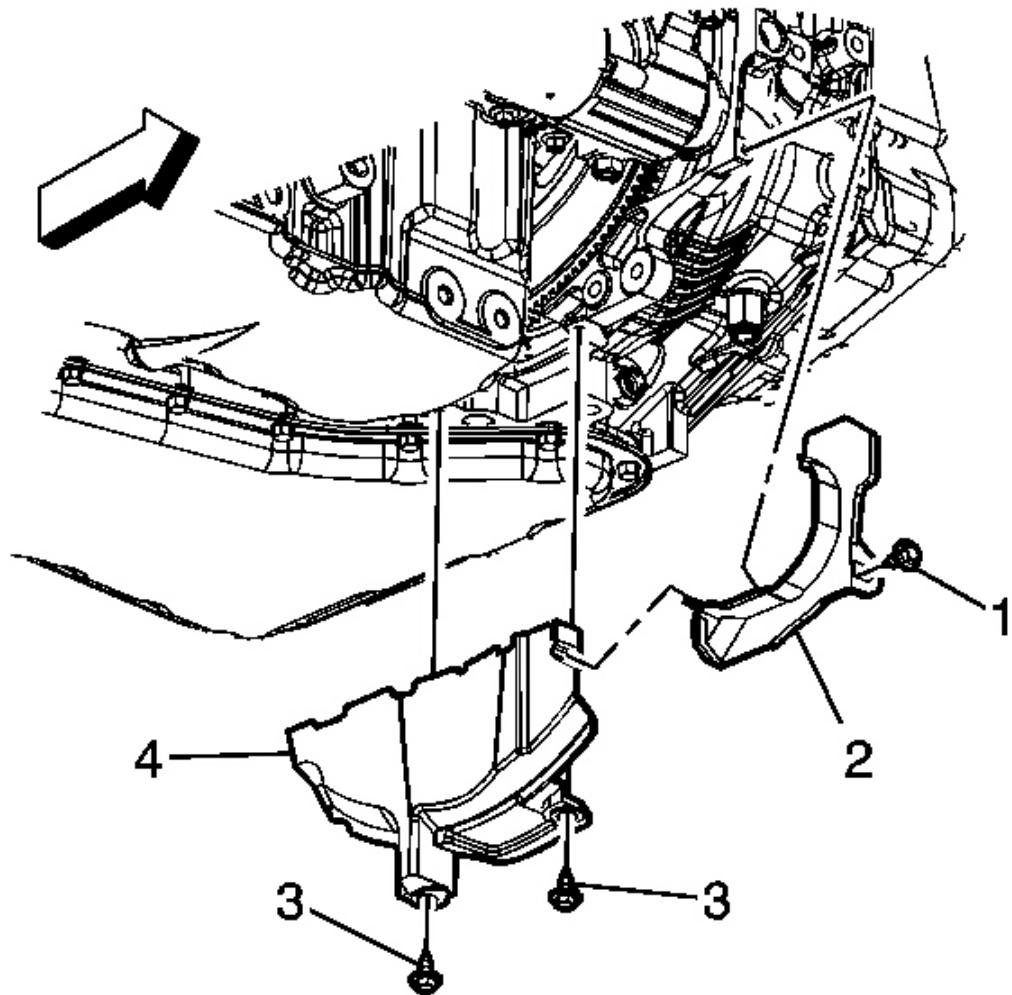
**2006 Buick Lucerne CXS**

2006 ENGINE Engine Mechanical - 3.8L - Lucerne



**Fig. 204: Identifying Transaxle Brace & Bolts**  
Courtesy of GENERAL MOTORS CORP.

16. Remove the transaxle brace.

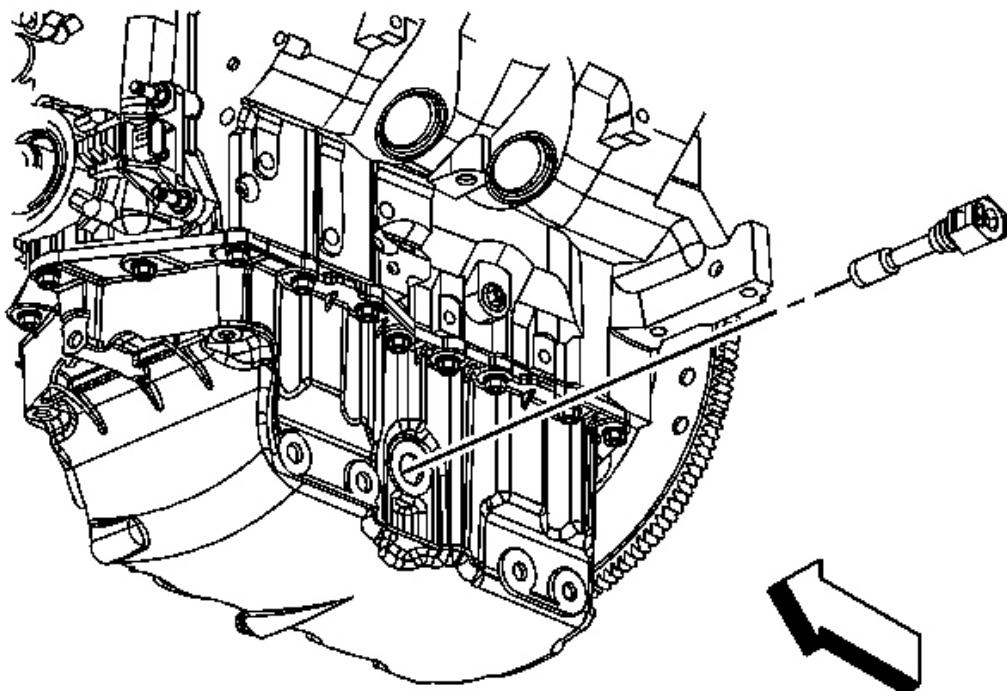


**Fig. 205: Identifying Transaxle Converter Cover**  
Courtesy of GENERAL MOTORS CORP.

17. Remove the front torque converter cover bolt (1).
18. Remove the front torque converter cover (2).
19. Remove the rear torque converter cover bolts (3).
20. Remove the rear torque converter cover (4).

**NOTE: Remove the oil level sensor, located in the oil pan, before the**

**oil pan is removed. The sensor may be damaged if the oil pan is removed first.**



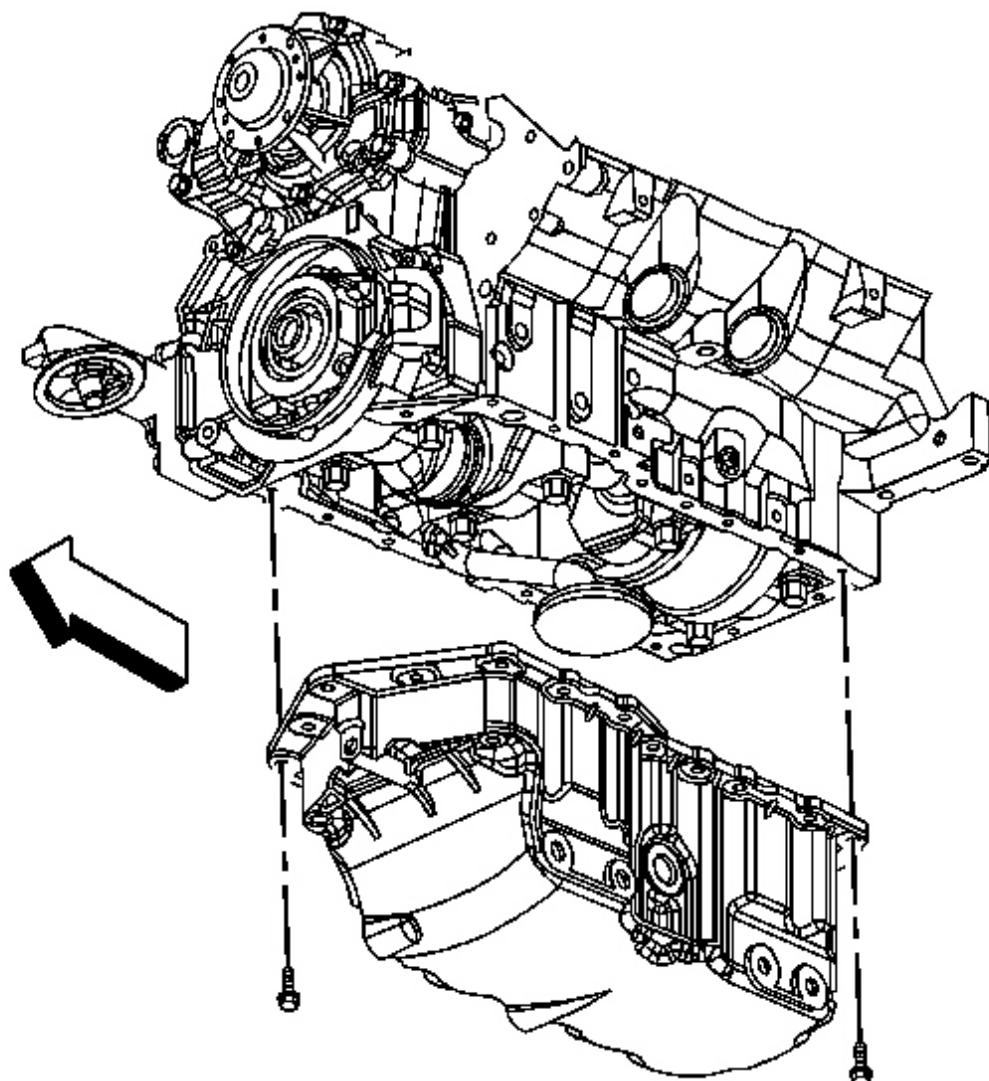
**Fig. 206: Identifying Oil Level Sensor**

Courtesy of GENERAL MOTORS CORP.

21. Remove the oil level sensor.

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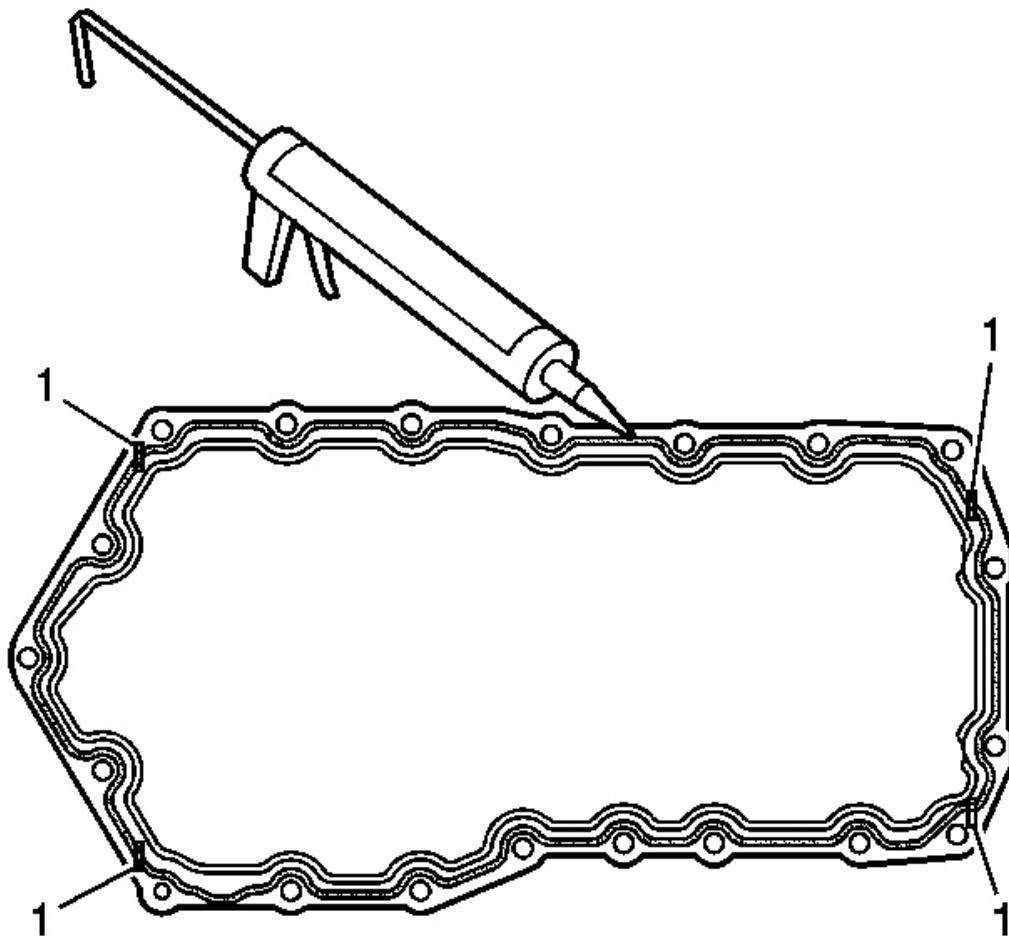
2006 ENGINE Engine Mechanical - 3.8L - Lucerne



**Fig. 207: View Of Oil Pan & Bolts**  
Courtesy of GENERAL MOTORS CORP.

22. Remove the oil pan bolts.
23. Remove the oil pan.
24. Clean the oil pan bolts of all debris.

## Installation Procedure

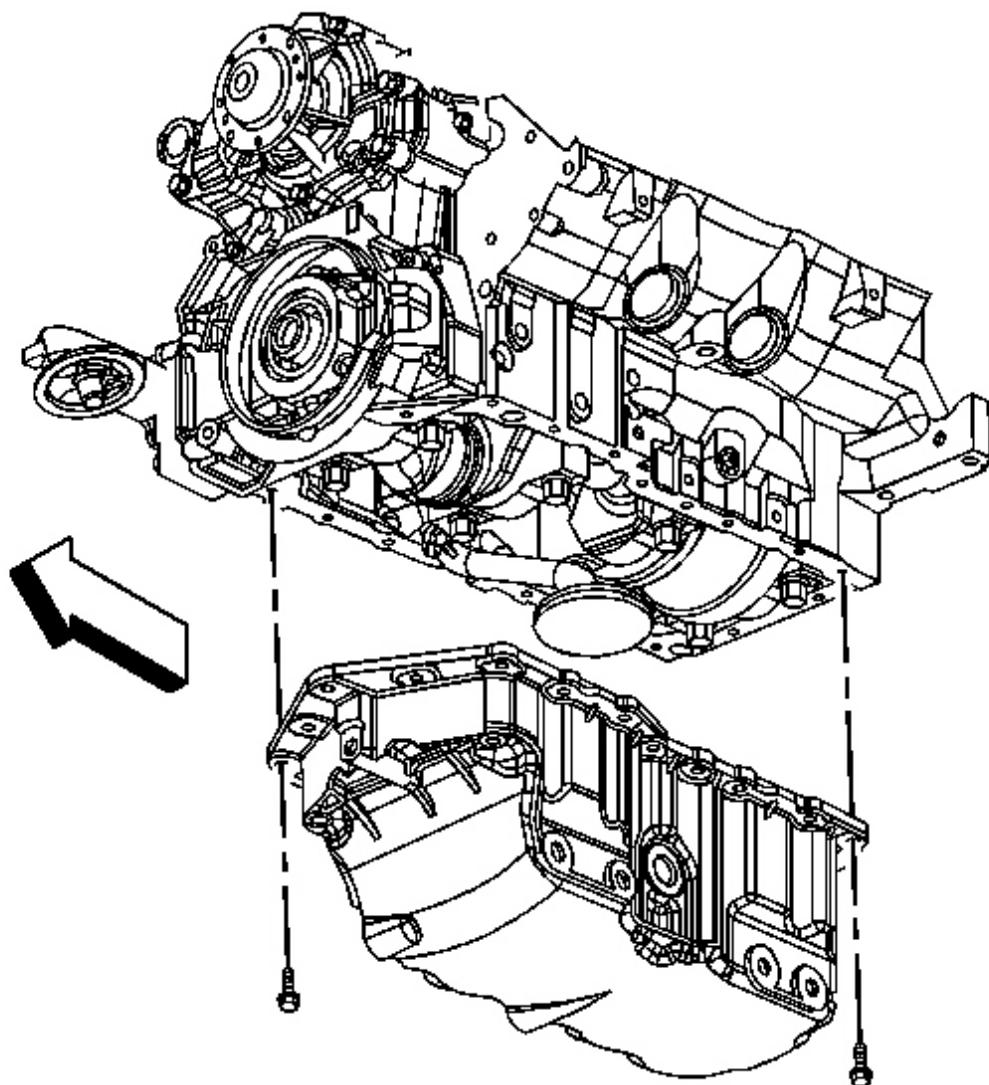


**Fig. 208: Applying Additional Windage Tray Gasket Sealer Locations**  
Courtesy of GENERAL MOTORS CORP.

1. Apply a continuous bead 6.35 mm (0.25 in) thick of RTV sealer, ensuring that the sealer also completely fills the groove in the oil pan. Refer to Sealers, Adhesives and Lubricants for the correct part number.
2. To ensure proper sealing, apply additional sealer at the four locations (1).

**NOTE:** **Install the oil level sensor, located in the oil pan, after the oil pan is installed. The sensor may be damaged if the oil level**

**sensor is installed first.**



**Fig. 209: View Of Oil Pan & Bolts**

Courtesy of GENERAL MOTORS CORP.

3. Apply a drop of threadlock to each bolt. Refer to **Sealers, Adhesives and Lubricants** for the correct part number.

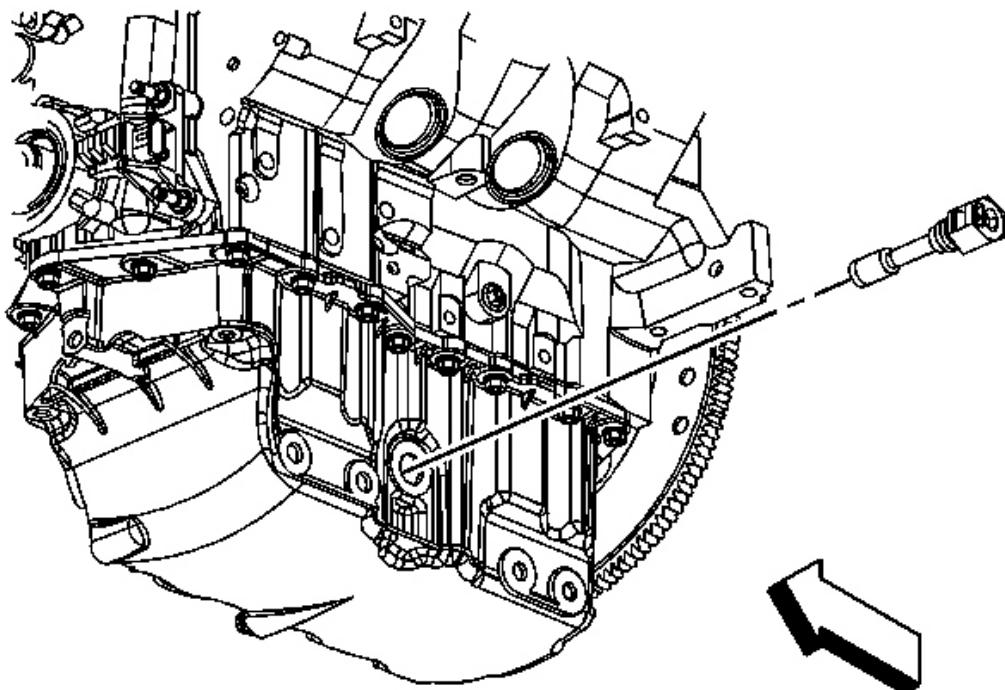
4. Position the oil pan to the engine.

**NOTE:** Refer to Fastener Notice .

**IMPORTANT: DO NOT overtighten the oil pan bolts or damage to the oil pan may occur, resulting in an oil leak.**

5. Install the oil pan bolts.

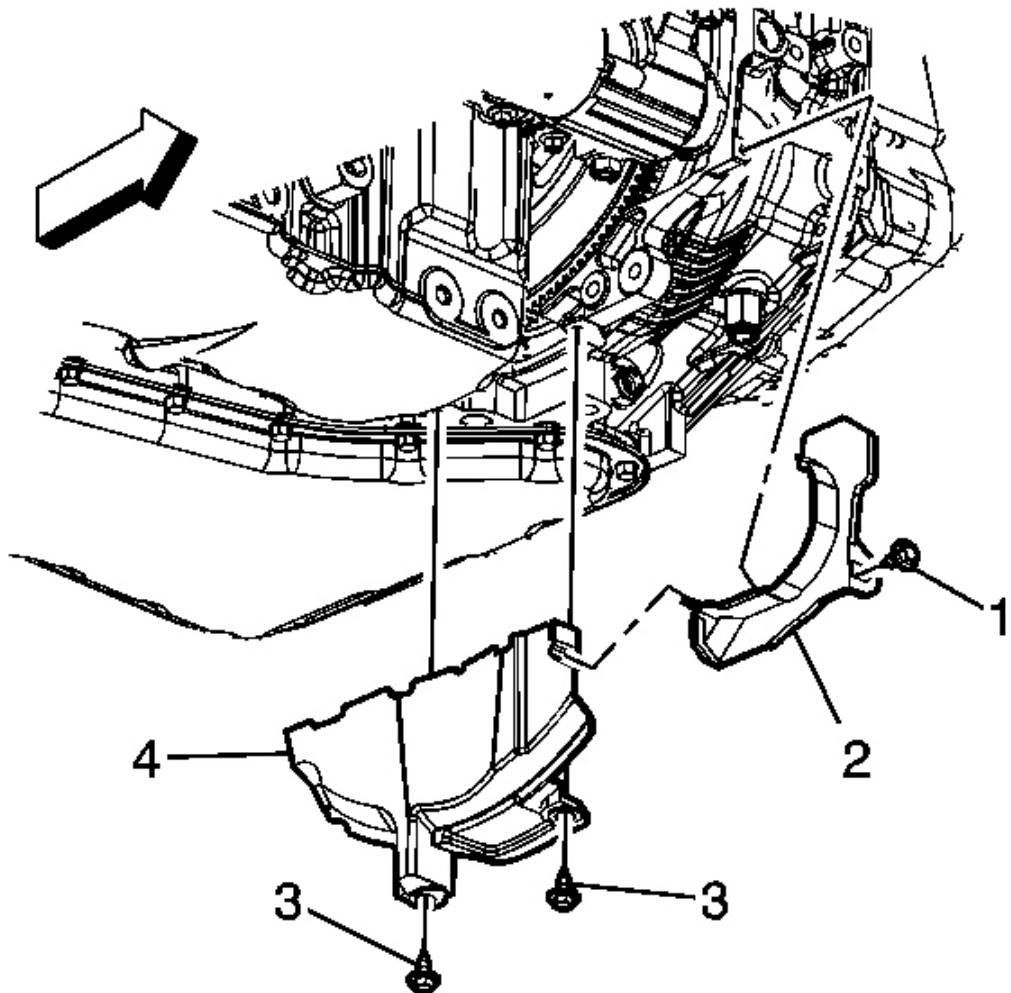
**Tighten:** Tighten the bolts to 14 N.m (10 lb ft).



**Fig. 210: Identifying Oil Level Sensor**  
Courtesy of GENERAL MOTORS CORP.

6. Install the oil level sensor.

**Tighten:** Tighten the sensor to 20 N.m (15 lb ft).



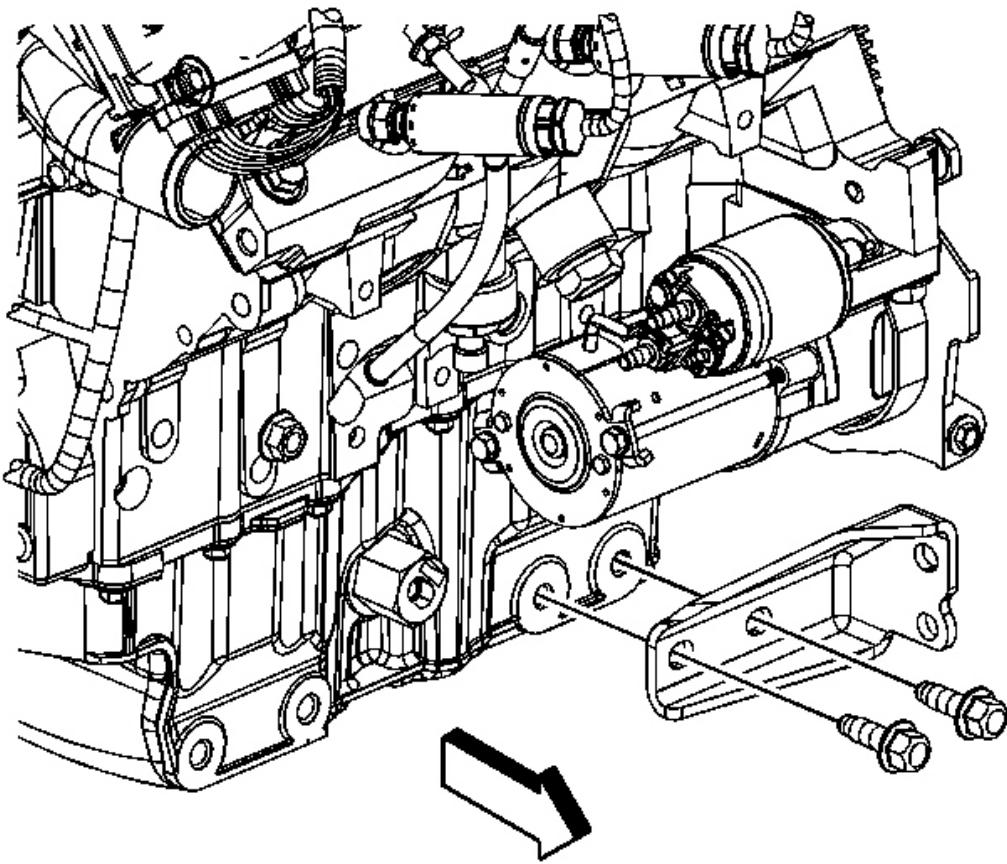
**Fig. 211: Identifying Transaxle Converter Cover**  
Courtesy of GENERAL MOTORS CORP.

7. Position the rear torque converter cover (4).
8. Install the rear torque converter cover bolts (3).

**Tighten:** Tighten the bolts to 7.5 N.m (66 lb in).

9. Position the front torque converter cover (2).
10. Install the front torque converter cover bolt (1).

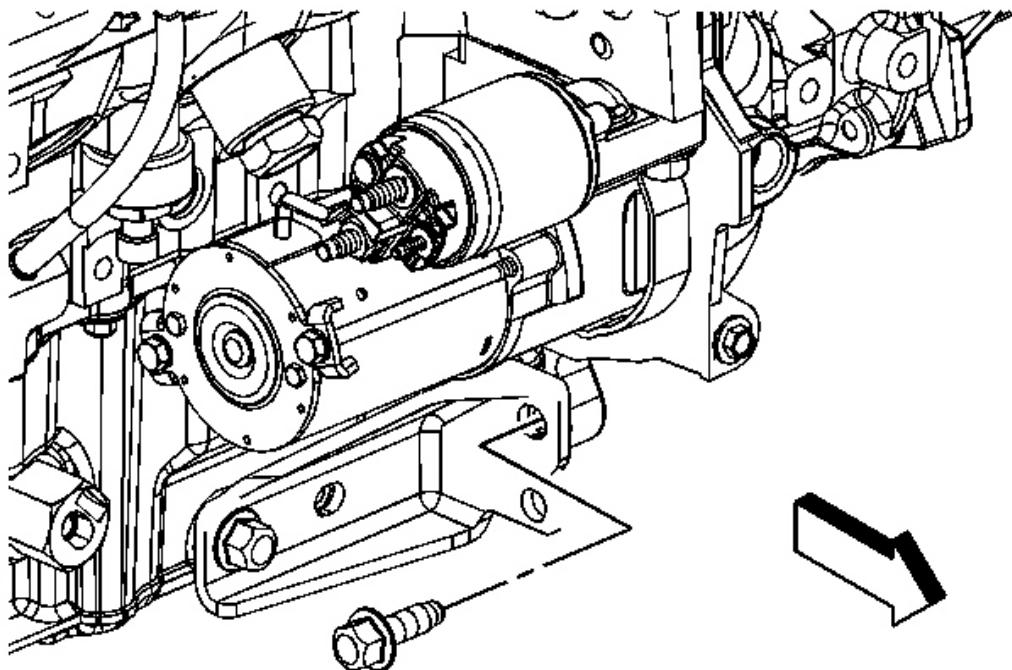
**Tighten:** Tighten the bolts to 7.5 N.m (66 lb in).



**Fig. 212: Identifying Transaxle Brace & Bolts**  
Courtesy of GENERAL MOTORS CORP.

11. Position the transaxle brace.
12. Install the transaxle brace to oil pan bolts.

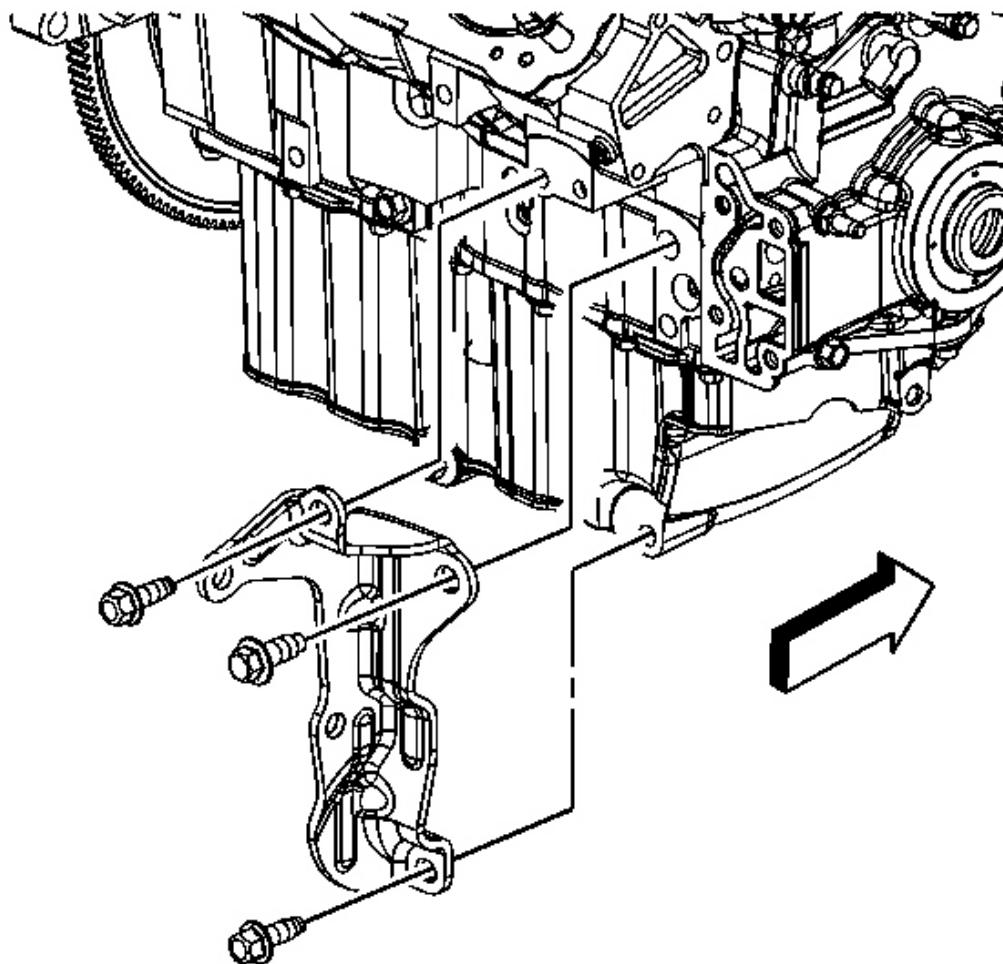
**Tighten:** Tighten the bolts to 50 N.m (37 lb ft).



**Fig. 213: Identifying Transaxle Brace-To-Transaxle & Bolts**  
Courtesy of GENERAL MOTORS CORP.

13. Install the transaxle brace to transaxle bolts.

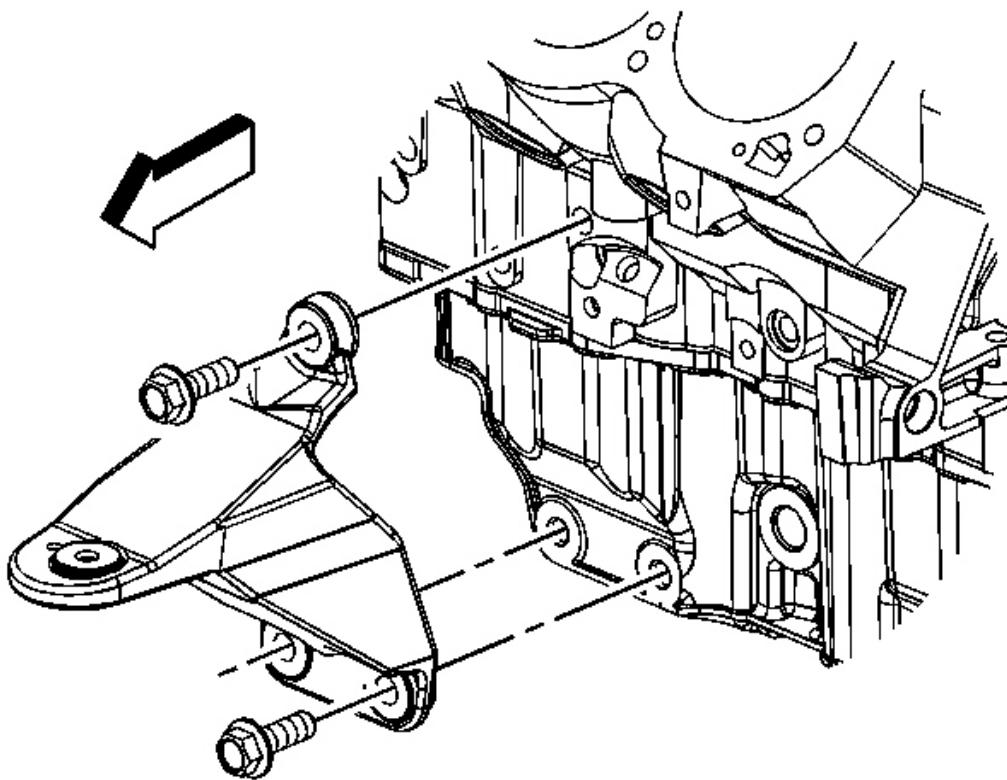
**Tighten:** Tighten the bolts to 50 N.m (37 lb ft).



**Fig. 214: Identifying Transaxle Brace-To-Oil Pan & Bolts**  
Courtesy of GENERAL MOTORS CORP.

14. Install the transaxle brace to oil pan bolt.

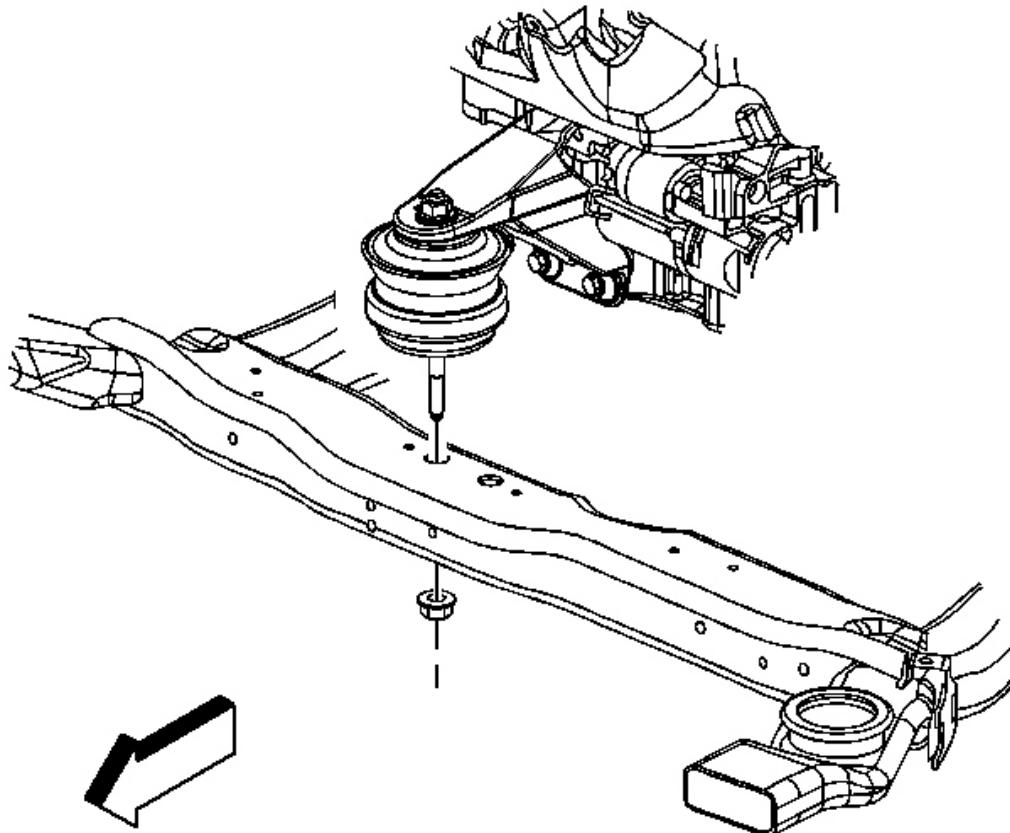
**Tighten:** Tighten the bolts to 50 N.m (37 lb ft).



**Fig. 215: View Of Engine Mount Bracket & Bolts**  
Courtesy of GENERAL MOTORS CORP.

15. Position the front engine mount bracket with mount.
16. Install the front engine mount bracket bolts.

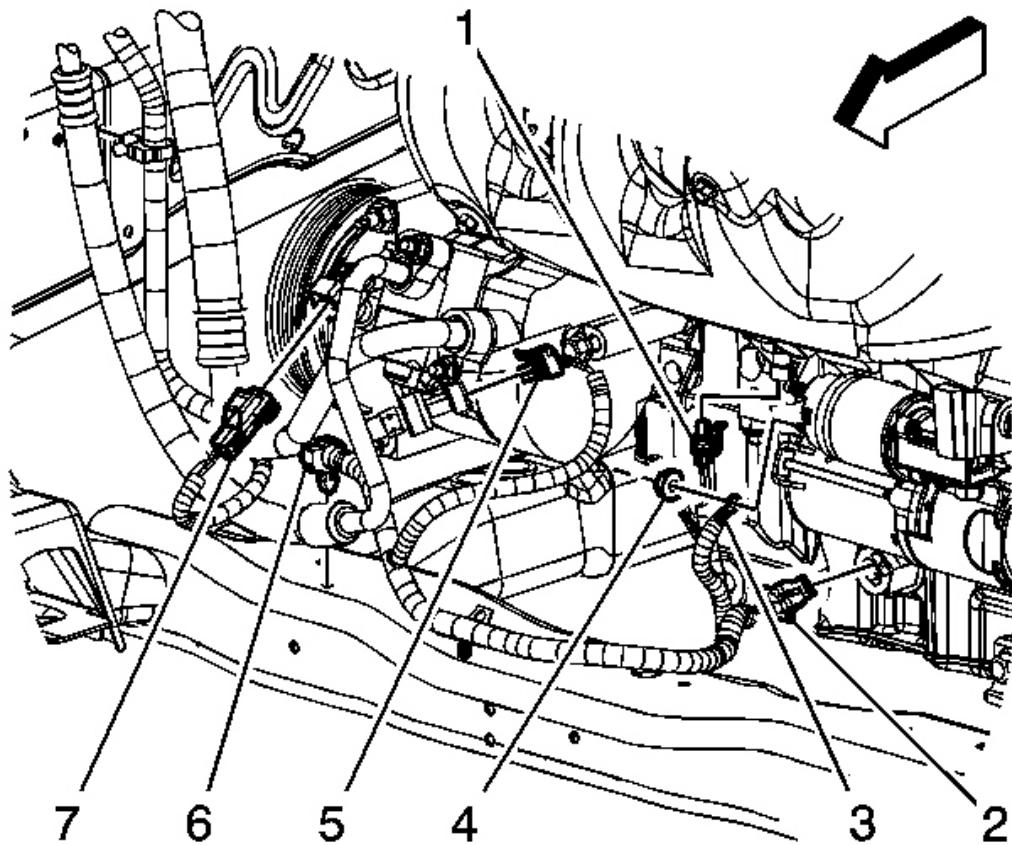
**Tighten:** Tighten the bolts to 70 N.m (52 lb ft).



**Fig. 216: Identifying Engine Front Mount-To-Frame Nut**  
Courtesy of GENERAL MOTORS CORP.

17. Lower the vehicle.
18. Using the engine support fixture, lower the engine.
19. Raise the vehicle.
20. Install the front engine mount to frame nut.

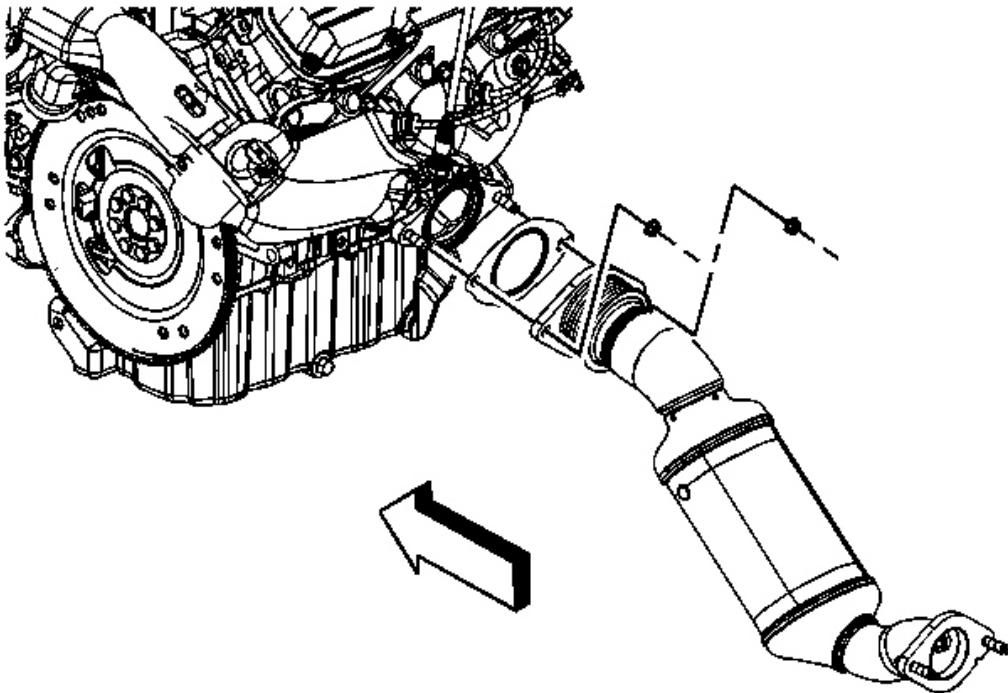
**Tighten:** Tighten the nut to 80 N.m (59 lb ft).



**Fig. 217: View Of Engine Harness Electrical Connectors**

Courtesy of GENERAL MOTORS CORP.

21. Connect the engine harness electrical connector (2) to the oil level sensor.

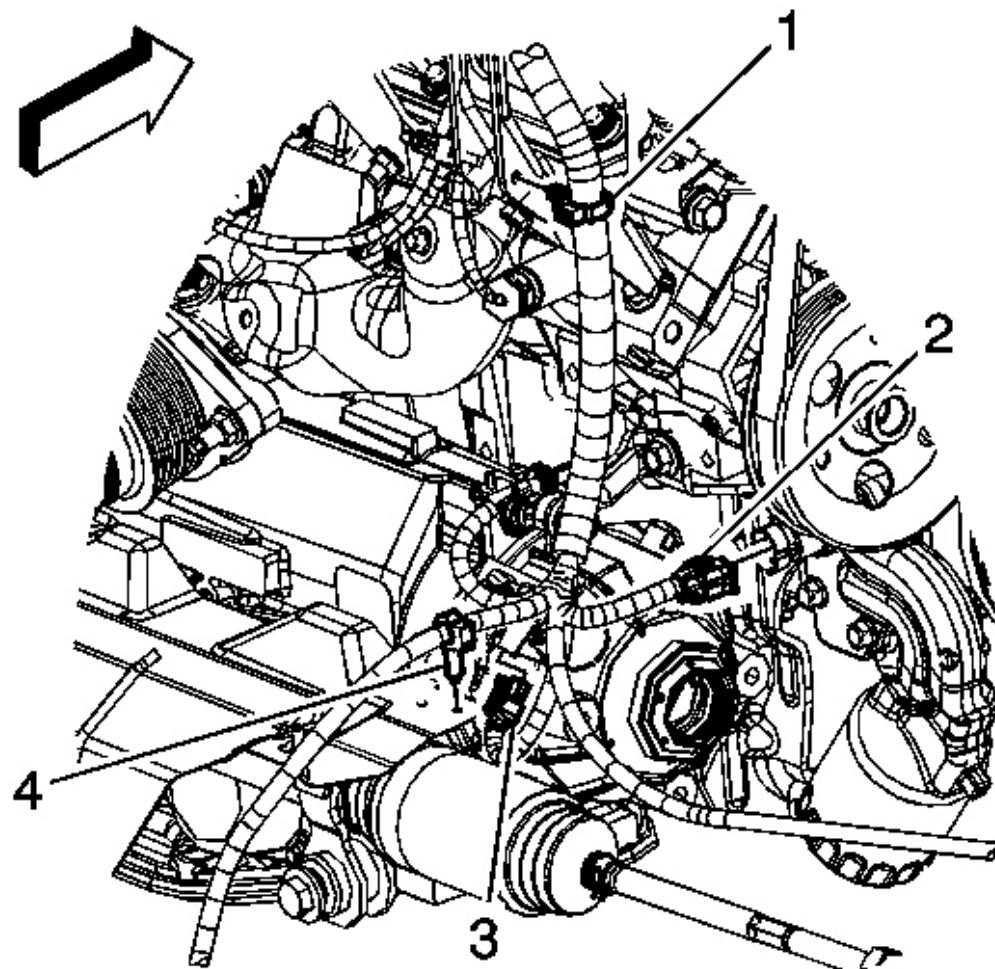


**Fig. 218: View Of Catalytic Converter-To-Exhaust Manifold Nuts**  
Courtesy of GENERAL MOTORS CORP.

22. Remove the catalytic converter to exhaust manifold nuts.  
**Tighten:** Tighten the nuts to 35 N.m (26 lb ft).
23. Lower the vehicle.
24. Install the air cleaner intake duct. Refer to [Air Cleaner Outlet Duct Replacement](#) .
25. Install the engine support fixture. Refer to [Engine Support Fixture](#).
26. Install the oil filter and refill the engine with oil. Refer to [Engine Oil and Oil Filter Replacement](#).

#### **ENGINE OIL PRESSURE SENSOR AND/OR SWITCH REPLACEMENT**

##### **Removal Procedure**

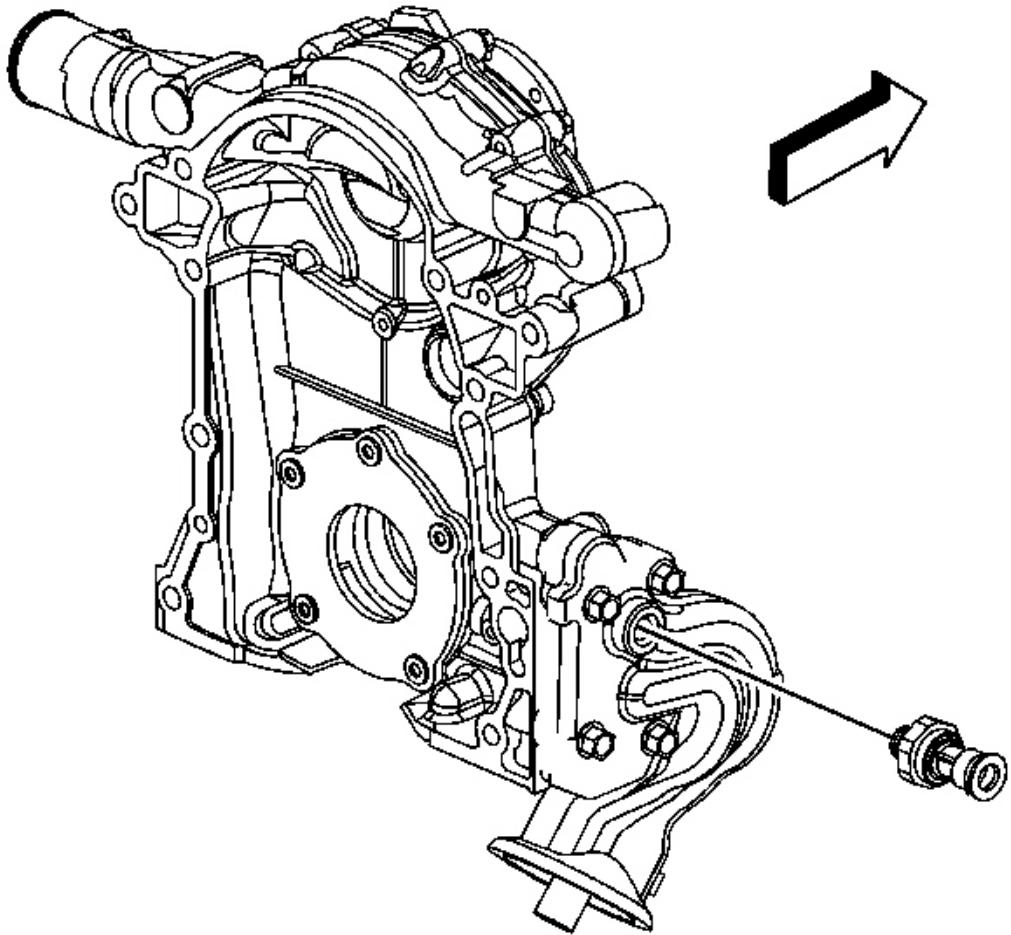


**Fig. 219: Identifying Oil Pressure Sensor Connector**  
Courtesy of GENERAL MOTORS CORP.

1. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#) .
2. Disconnect the engine harness electrical connector (2) from the oil pressure sensor.

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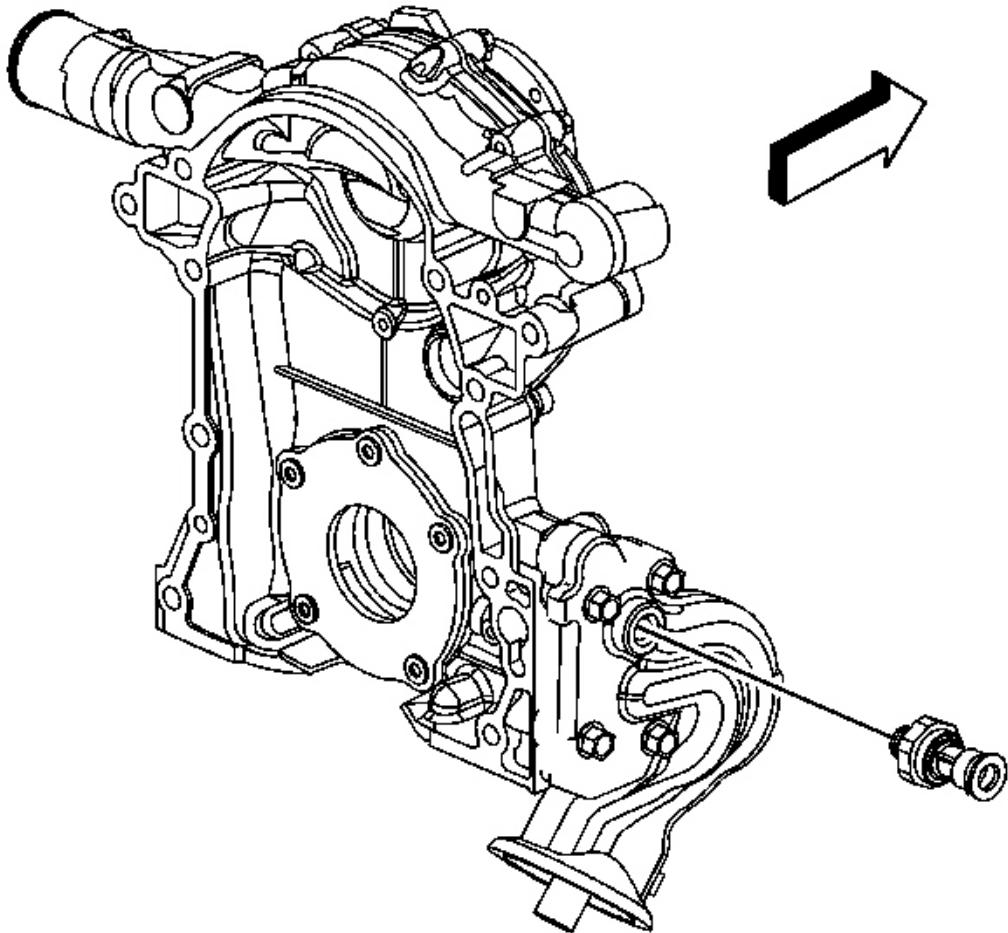
2006 ENGINE Engine Mechanical - 3.8L - Lucerne



**Fig. 220: Identifying Oil Pressure Sensor**  
Courtesy of GENERAL MOTORS CORP.

3. Remove the oil pressure sensor.

**Installation Procedure**

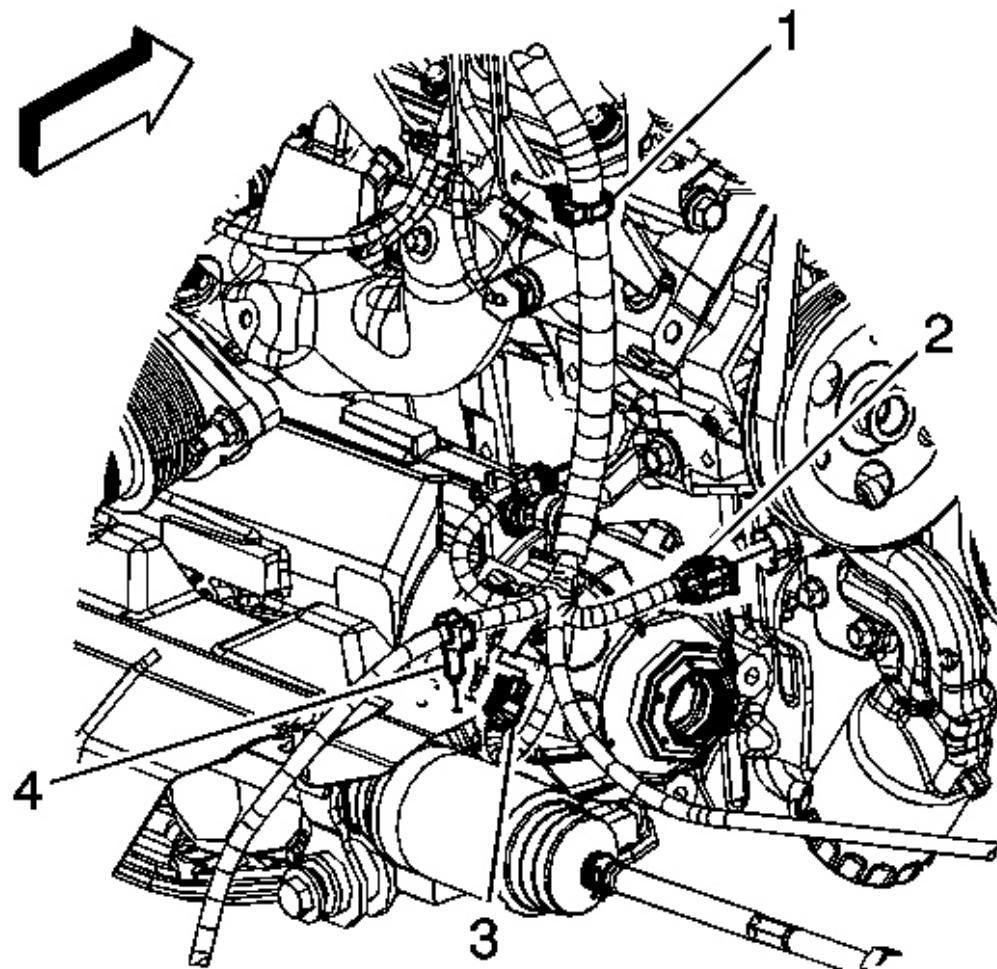


**Fig. 221: Identifying Oil Pressure Sensor**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Refer to Fastener Notice .

1. Install the engine oil pressure sensor.

**Tighten:** Tighten the sensor to 16 N.m (12 lb ft).

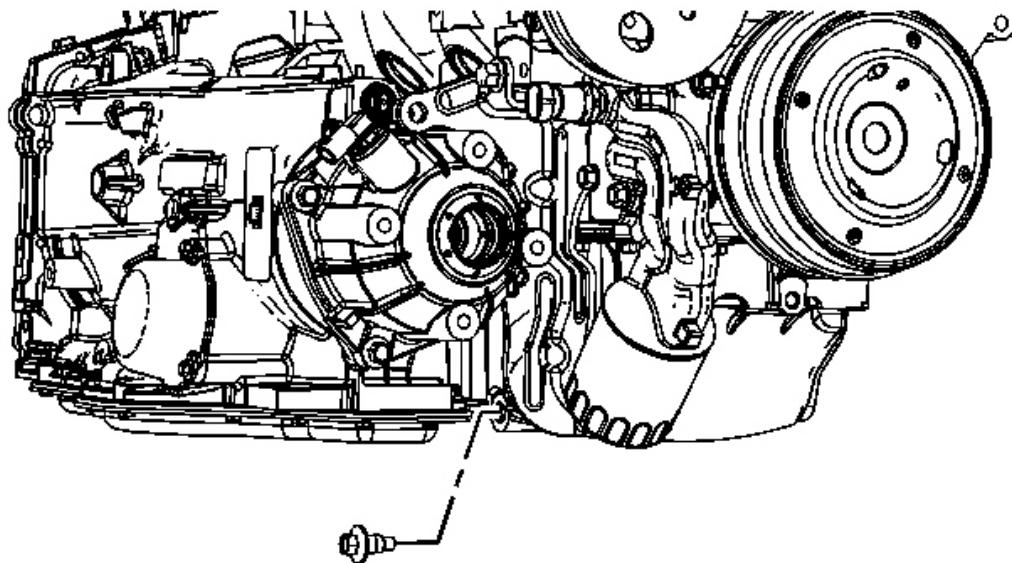


**Fig. 222: Identifying Oil Pressure Sensor Connector**  
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the engine harness electrical connector (2) to the oil pressure sensor.
3. Lower the vehicle.

#### **ENGINE OIL LEVEL SENSOR AND/OR SWITCH REPLACEMENT**

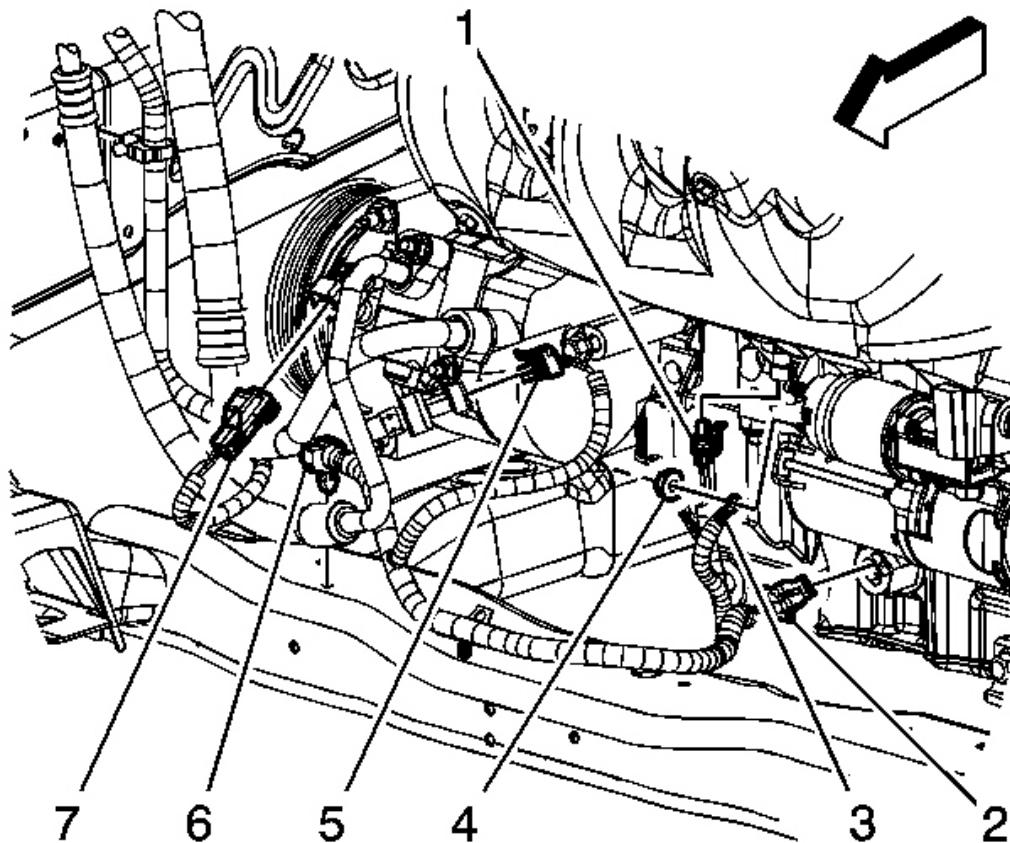
##### **Removal Procedure**



**Fig. 223: Identifying Oil Pan Drain Plug**

Courtesy of GENERAL MOTORS CORP.

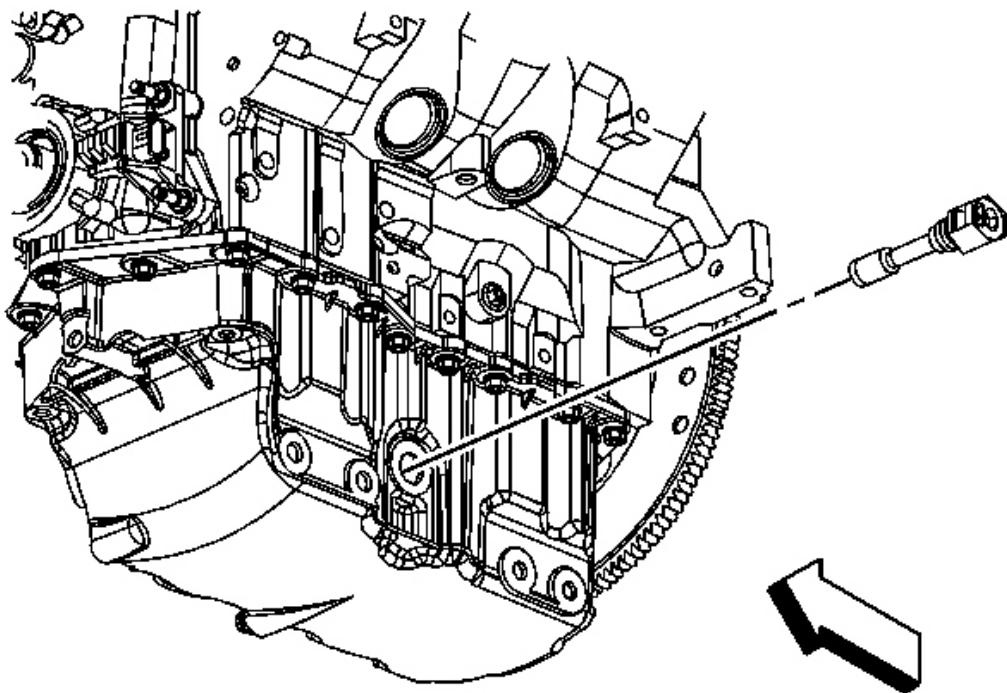
1. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#) .
2. Remove the oil pan drain plug and allow the oil to drain.



**Fig. 224: View Of Engine Harness Electrical Connectors**

Courtesy of GENERAL MOTORS CORP.

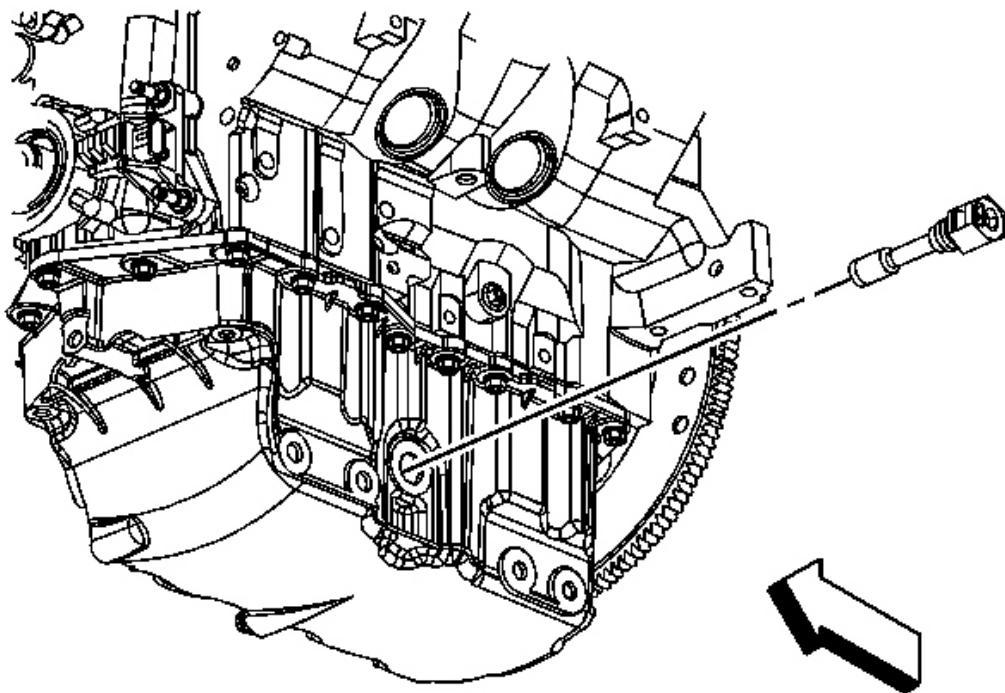
3. Disconnect the engine harness electrical connector (2) from the oil level sensor.



**Fig. 225: Identifying Oil Level Sensor**  
Courtesy of GENERAL MOTORS CORP.

4. Remove the oil level sensor.

**Installation Procedure**

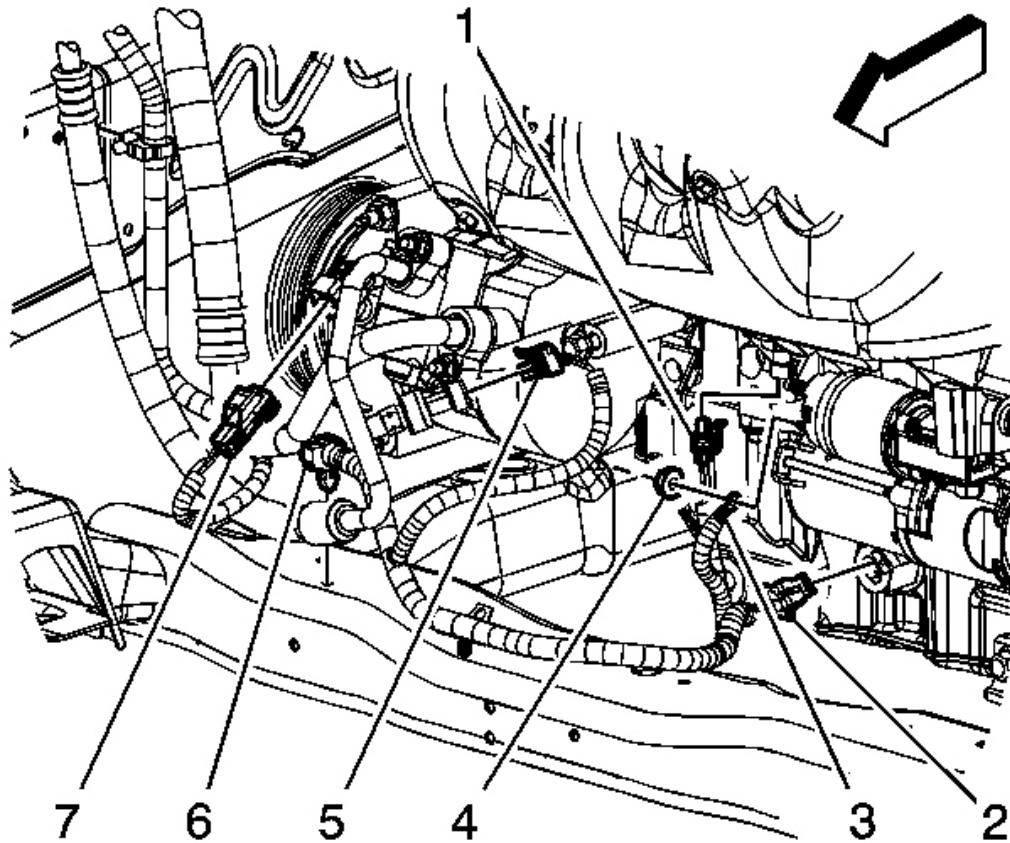


**Fig. 226: Identifying Oil Level Sensor**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Refer to Fastener Notice .

1. Install the oil level sensor.

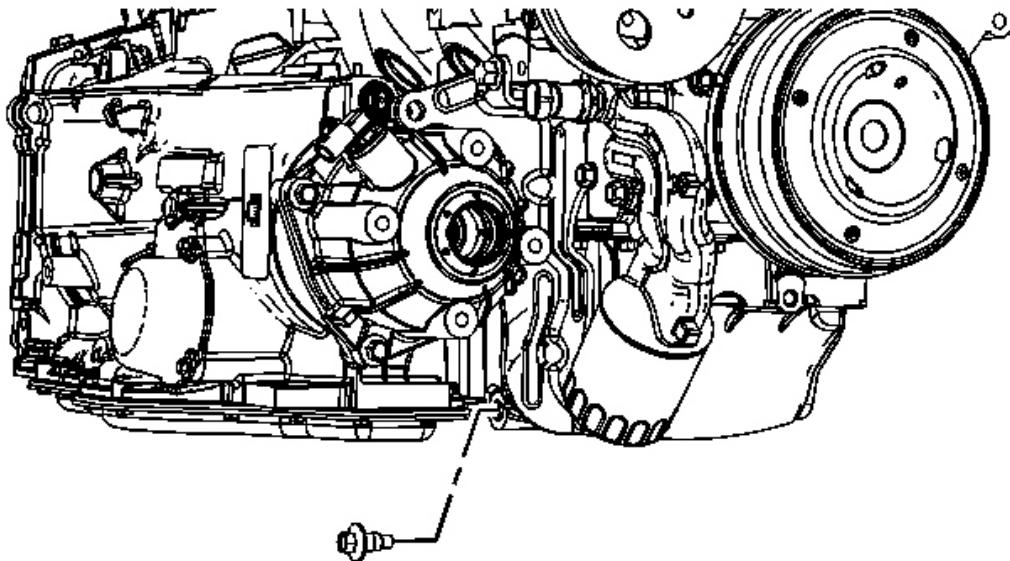
**Tighten:** Tighten the sensor to 20 N.m (15 lb ft).



**Fig. 227: View Of Engine Harness Electrical Connectors**

Courtesy of GENERAL MOTORS CORP.

2. Connect the engine harness electrical connector (2) to the oil level sensor.



**Fig. 228: Identifying Oil Pan Drain Plug**  
Courtesy of GENERAL MOTORS CORP.

3. Install the oil pan drain plug.

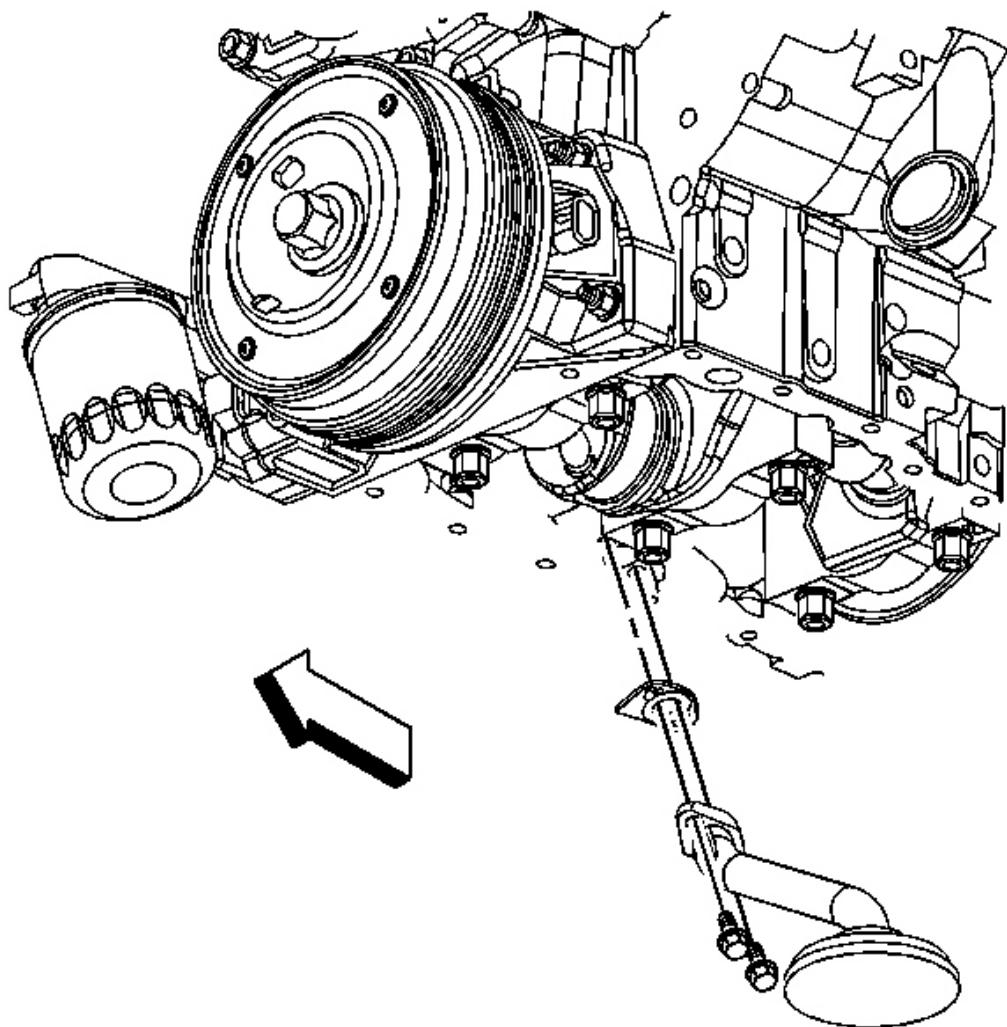
**Tighten:** Tighten the plug to 30 N.m (22 lb ft).

4. Lower the vehicle.
5. Fill the crankcase with engine oil. Refer to Approximate Fluid Capacities .

#### OIL PUMP SUCTION PIPE AND SCREEN ASSEMBLY REPLACEMENT

##### Removal Procedure

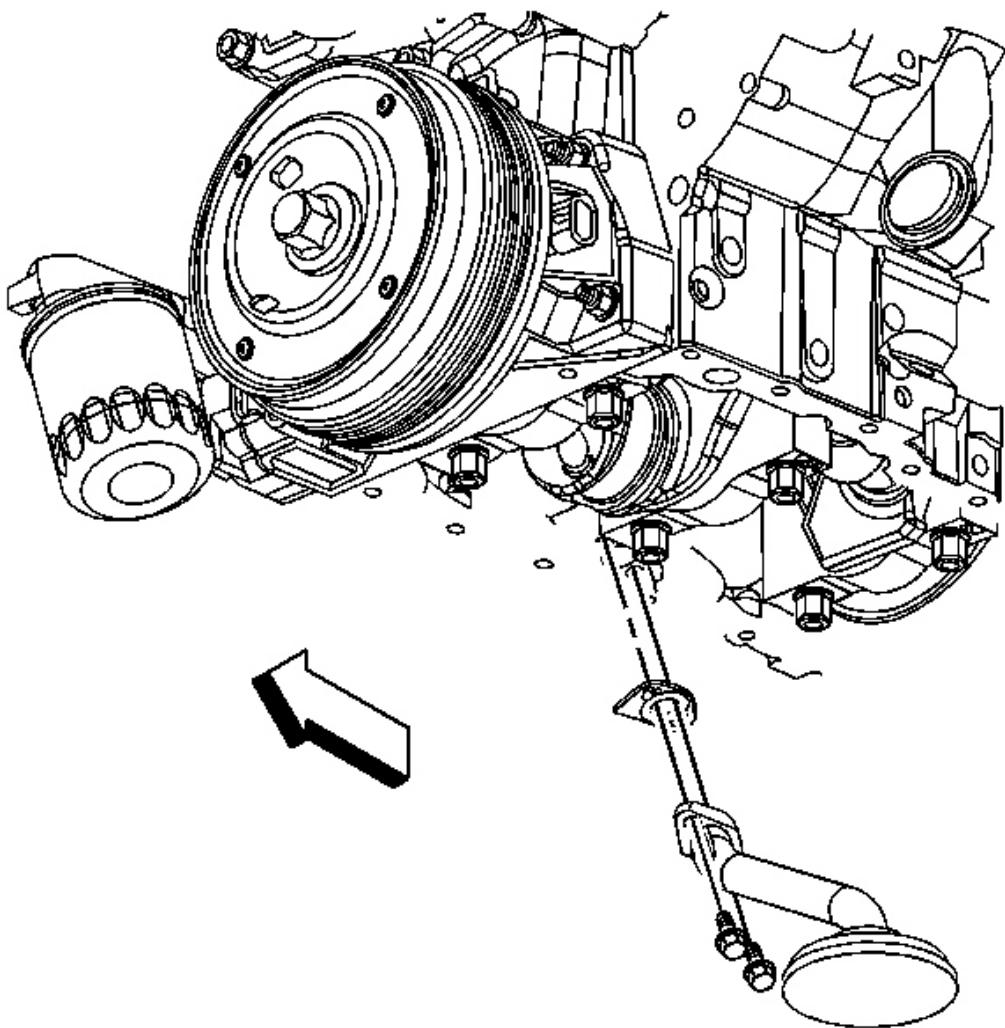
**NOTE:** Remove the oil level sensor, located in the oil pan, before the oil pan is removed. The sensor may be damaged if the oil pan is removed first.



**Fig. 229: Identifying Oil Pump Suction Pipe & Screen Assembly**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil pan. Refer to [Oil Pan Replacement](#).
2. Remove the oil pump screen bolts.
3. Remove the oil pump screen.
4. Remove the oil pump screen gasket.
5. Clean the gasket mating surface on the pipe flange and the cylinder block.

Installation Procedure



**Fig. 230: Identifying Oil Pump Suction Pipe & Screen Assembly**  
Courtesy of GENERAL MOTORS CORP.

1. Insert a bolt through the oil pump screen flange bolt hole and place the NEW oil pump screen gasket onto the flange.
2. Install the oil pump screen.
3. Install the other oil pump screen bolt and tighten the bolts.

**NOTE:** Refer to Fastener Notice .

**Tighten:** Tighten the bolts to 15 N.m (11 lb ft).

4. Install the oil pan. Refer to Oil Pan Replacement.

**NOTE:** Do not run the engine until the oil pressure is tested. Running the engine without measurable oil pressure will cause extensive damage.

**NOTE:** Stop the engine and remove the oil pan if the oil pressure does not build up immediately. Check the oil pump pipe and the screen for a clogged screen, damaged pipe or a damaged gasket. Running the engine without measurable oil pressure will cause extensive damage.

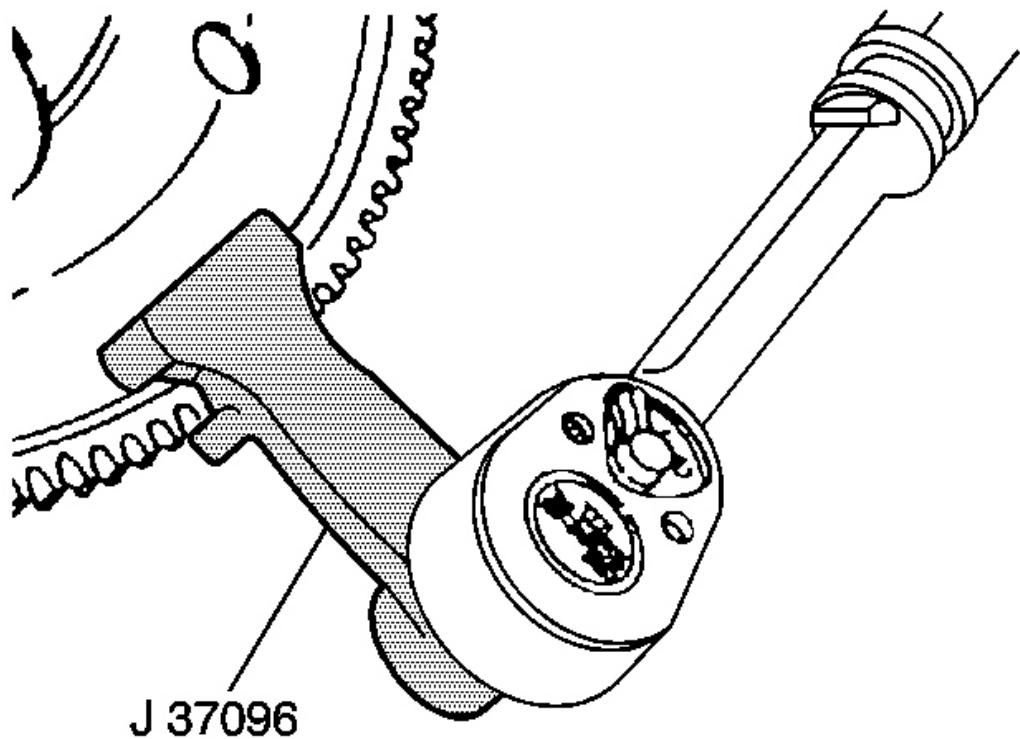
5. Inspect and verify that the oil pressure is within specifications.

## ENGINE FLYWHEEL REPLACEMENT

### Tools Required

- **J 45059** Torque Angle Meter. See Special Tools.
- **J 37096** Flywheel Holder. See Special Tools.

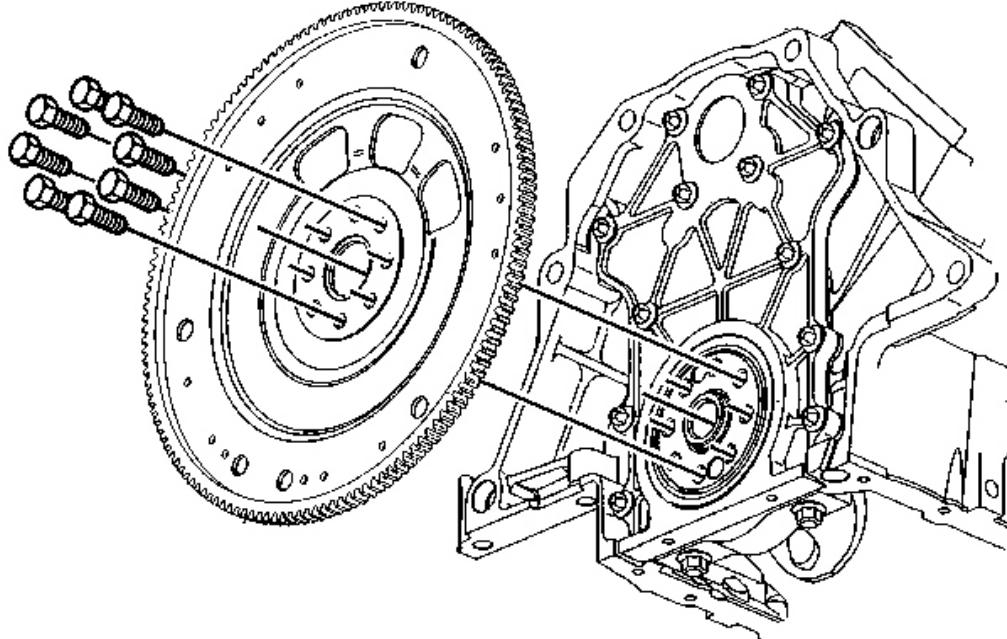
### Removal Procedure



**Fig. 231: Holding Flywheel**

Courtesy of GENERAL MOTORS CORP.

1. Remove the transaxle. Refer to [Transmission Replacement](#) .
2. Install the **J 37096** to a ratchet. See [Special Tools](#).
3. Install the **J 37096** and ratchet to the flywheel to hold the flywheel. See [Special Tools](#).

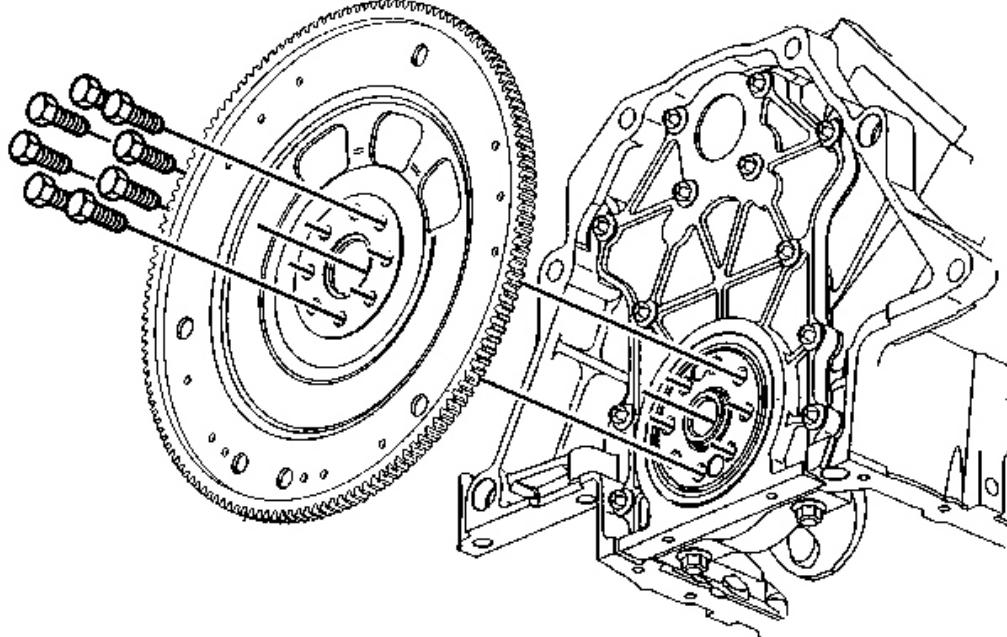


**Fig. 232: View Of Engine Flywheel & Bolts**

Courtesy of GENERAL MOTORS CORP.

4. Loosen the flywheel bolts.
5. Remove 7 of the 8 engine flywheel bolts, leaving 1 bolt at the top of the crankshaft rotation.
6. Firmly grasp the engine flywheel and remove the remaining bolt. Do not drop the engine flywheel when removing the final bolt.
7. Remove the flywheel.

**Installation Procedure**



**Fig. 233: View Of Engine Flywheel & Bolts**

Courtesy of GENERAL MOTORS CORP.

1. Install the flywheel.
2. Install NEW flywheel bolts until snug.
3. Install the **J 37096** and ratchet to the flywheel to hold the flywheel. See **Special Tools**.

**NOTE:** Refer to **Fastener Notice** .

4. Tighten the flywheel bolts.

**Tighten:** Tighten the bolts to 15 N.m (11 lb ft) plus an additional 50 degrees using **J 45059** . See **Special Tools**.

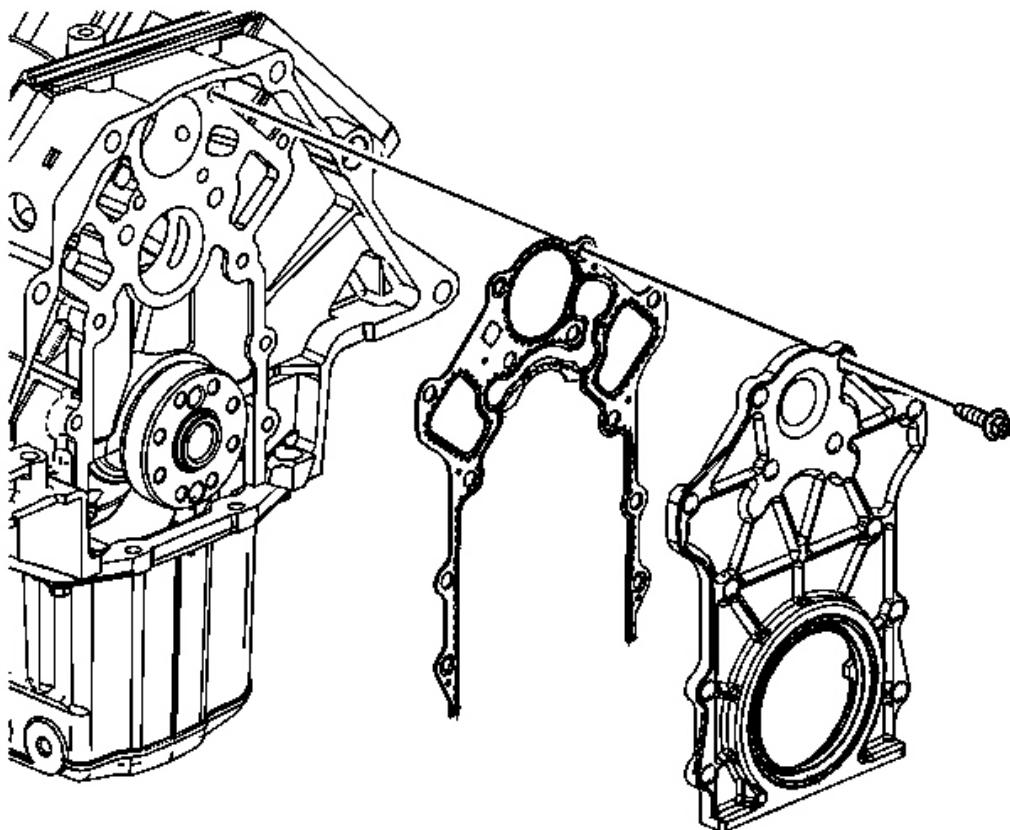
5. Install the transaxle. Refer to **Transmission Replacement** .

## CRANKSHAFT REAR OIL SEAL AND HOUSING REPLACEMENT

### Tools Required

- **EN-47623** Rear Main Seal Installer. See [Special Tools](#).
- **J 8092** Drive Handle
- **J 45059** Torque Angle Meter. See [Special Tools](#).

#### Removal Procedure

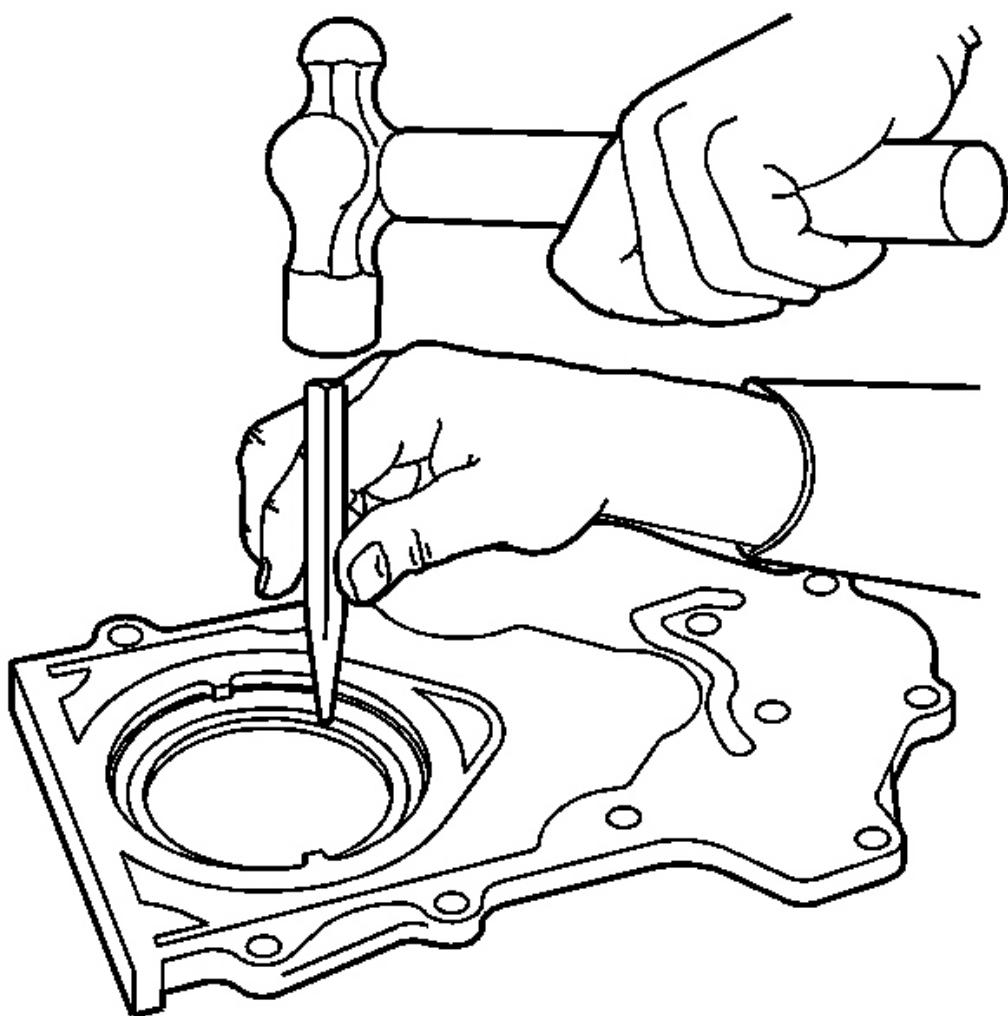


**Fig. 234: Crankshaft Rear Oil Seal & Housing (Second Design)**  
Courtesy of GENERAL MOTORS CORP.

1. Drain the cooling system. Refer to [Cooling System Draining and Filling \(Static Fill\)](#) or [Cooling System Draining and Filling \(Vac-N-Fill\)](#) .
2. Remove the engine flywheel. Refer to [Engine Flywheel Replacement](#).
3. Remove the oil pan. Refer to [Oil Pan Replacement](#).

**IMPORTANT: Ensure not to damage the crankshaft outside diameter surface with any tool.**

4. Remove the crankshaft rear oil seal housing bolts.
5. Remove the crankshaft rear oil seal housing and gasket.



**Fig. 235: Locating Crankshaft Rear Oil Seal In Housing**  
Courtesy of GENERAL MOTORS CORP.

6. Place the crankshaft rear oil seal housing face down on a clean surface and support with

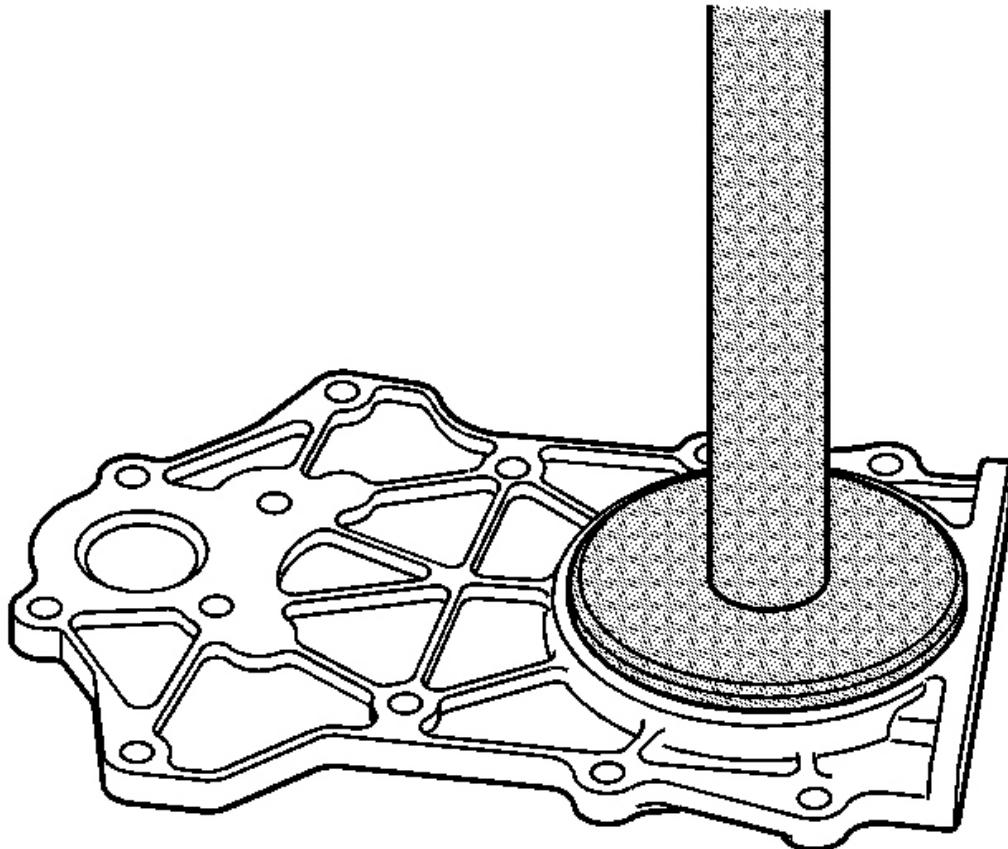
blocks of wood.

7. Use a suitable driving tool and hammer and lightly tap around the outer edge of the seal to remove it.
8. Inspect the crankshaft for nicks or burrs on the surface that contacts the seal.
9. Repair or replace the crankshaft, if necessary.

#### Installation Procedure

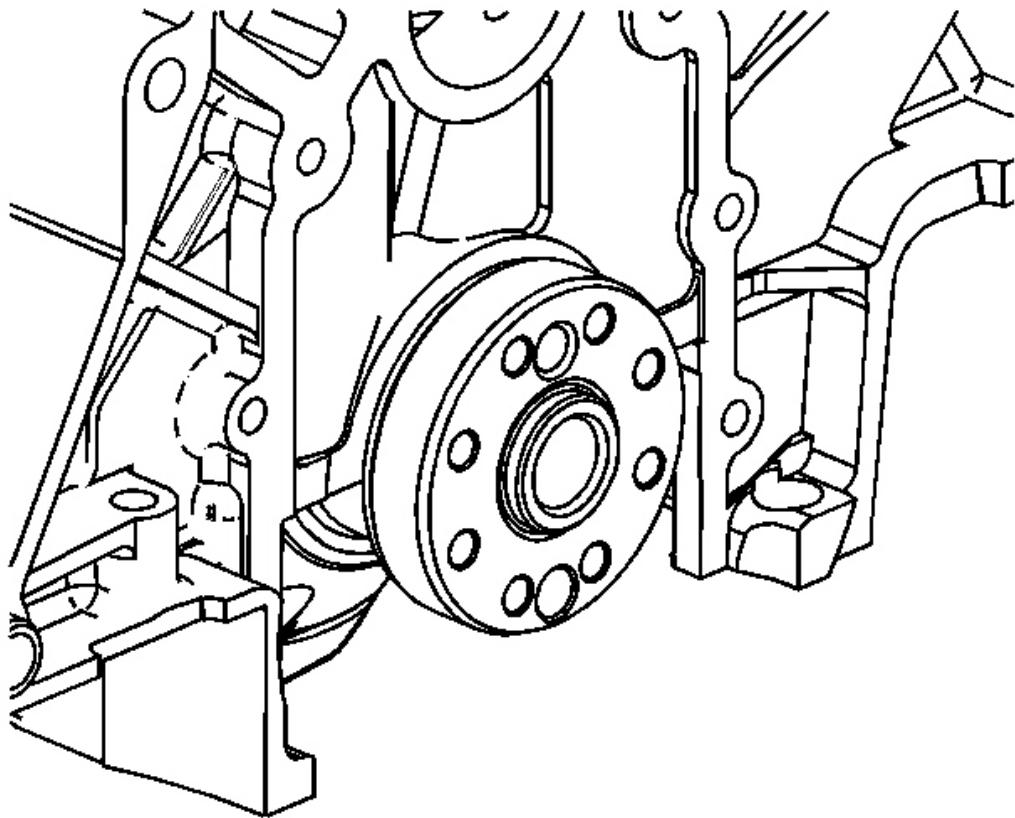
**NOTE:** **Do not apply or use any oil lubrication on the crankshaft rear oil seal or the seal installer. Do not touch the sealing lip of the oil seal once the protective sleeve is removed. Doing so will damage/deform the seal.**

**NOTE:** **Clean the crankshaft sealing surface with a clean, lint free towel. Inspect lead-in edge of crankshaft for burrs/sharp edges that could damage the rear main oil seal. Remove burrs/sharp edges with crocus cloth before proceeding.**



**Fig. 236: Installing Crankshaft Rear Oil Seal**  
Courtesy of GENERAL MOTORS CORP.

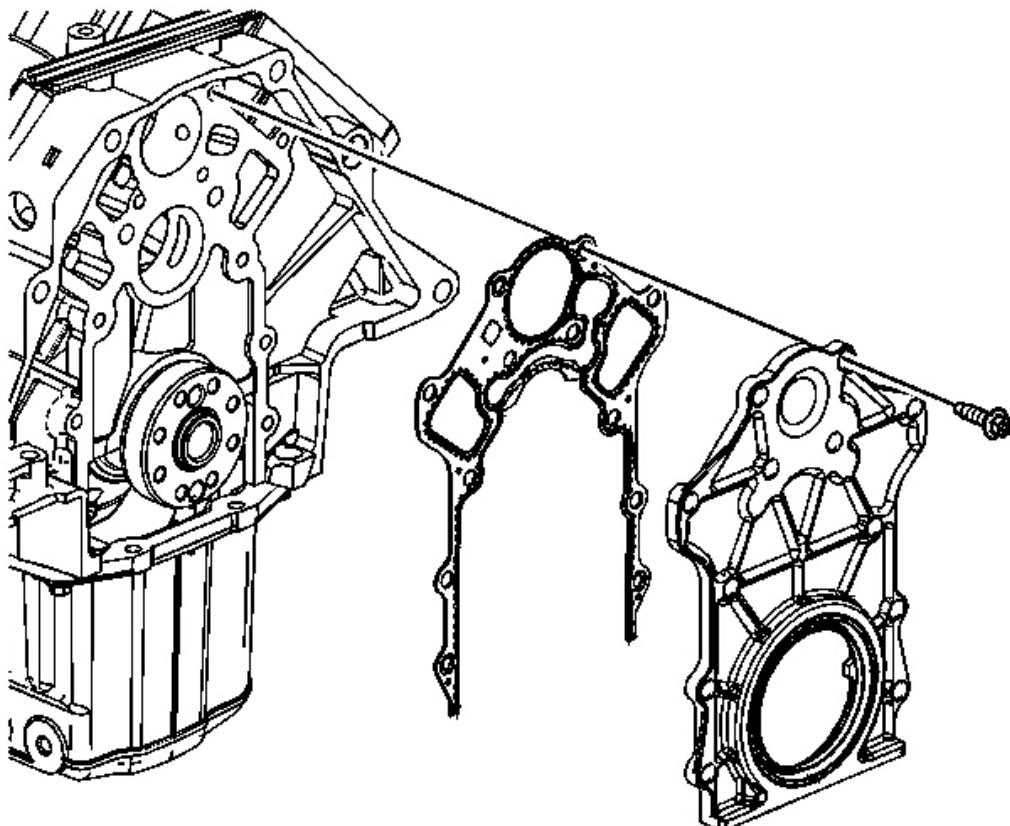
1. Clean and inspect the crankshaft rear oil seal housing making sure it is free of any foreign material.
2. With all bolts removed from the housing, place it face up on a flat clean surface.
3. Carefully remove the protection sleeve from the NEW rear oil seal.
4. Install the seal onto **EN-47623** by placing the seal on an angle and using a twisting motion until it is fully seated. See **Special Tools**.
5. Place **EN-47623** along with **J 8092** onto the housing as shown and apply a constant downward force until the seal is fully seated.



**Fig. 237: View Of Crankshaft Sealing Surface**

Courtesy of GENERAL MOTORS CORP.

6. Clean the crankshaft sealing surface with a clean, lint free towel. Inspect the crankshaft sealing surface and leading edge of the crankshaft for burrs/sharp edges that could damage the rear main oil seal. Remove any burrs or sharp edges with crocus cloth prior to proceeding.



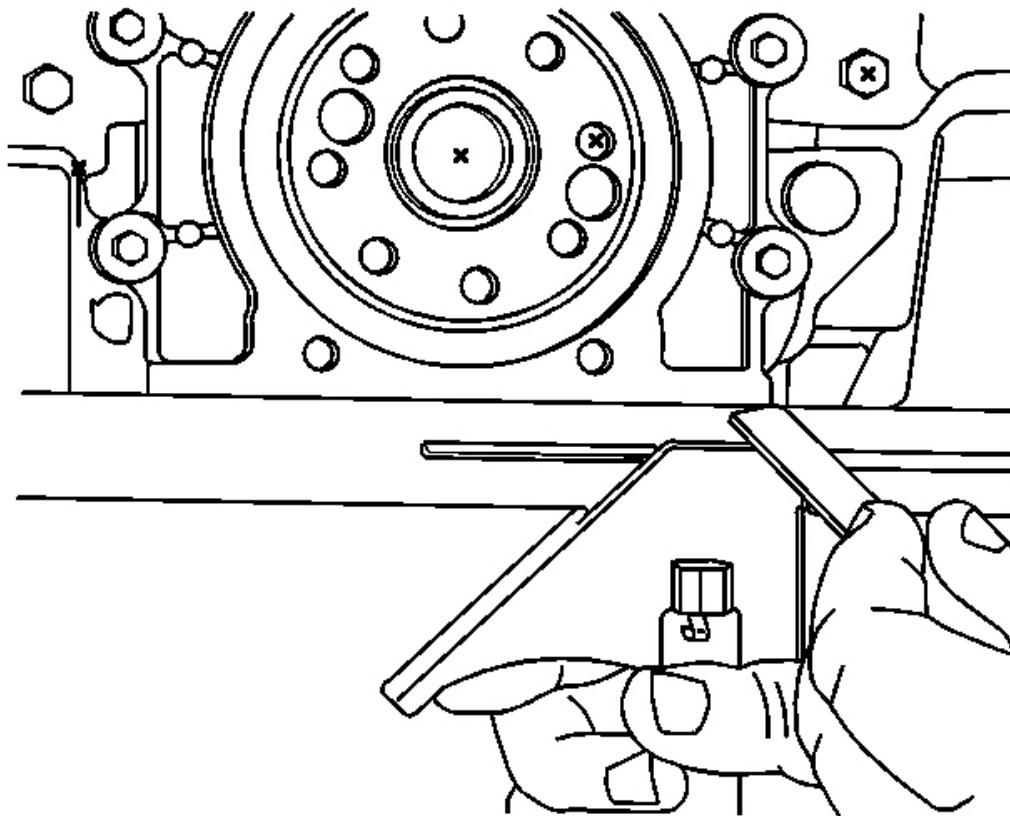
**Fig. 238: Crankshaft Rear Oil Seal & Housing (Second Design)**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT: Always install a NEW crankshaft rear oil seal housing gasket.**

7. Install a NEW crankshaft rear oil seal housing gasket and the housing onto the engine.

**IMPORTANT: The plastic inserts found in the rear oil seal housing retaining bolts are used to aid production assembly only. The inserts are not required for service.**

8. Install the crankshaft rear oil seal housing bolts finger tight.



**Fig. 239: Measuring Cylinder Block Oil Pan Flange & Rear Oil Seal Housing Flange**  
Courtesy of GENERAL MOTORS CORP.

9. Place a straight edge on the engine block oil pan flange and the crankshaft rear oil seal housing flange. Use a feeler gage to ensure there is no more than 0.10 mm (0.004 in) step on each side. If necessary, gently rotate the crankshaft rear oil seal housing to make the step equal on each side.

**NOTE:** Refer to Fastener Notice .

10. Tighten the crankshaft rear oil seal housing bolts.

**Tighten:** Tighten the bolts to 15 N.m (11 lb ft) plus an additional 50 degrees using **J 45059** . See Special Tools.

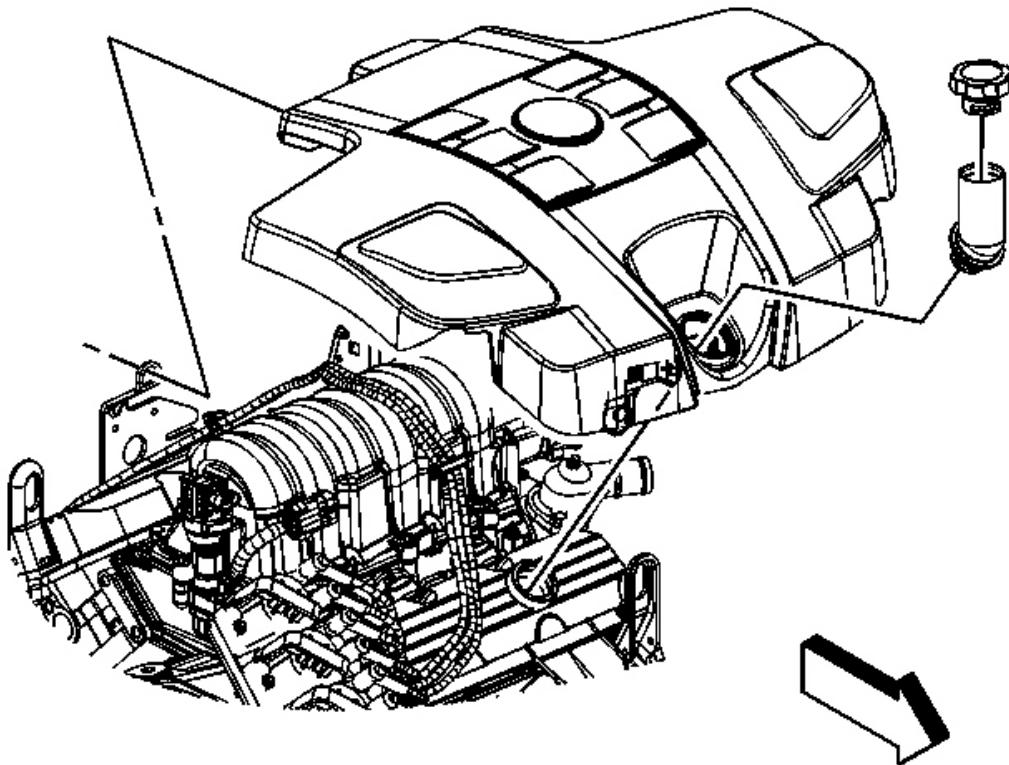
11. Recheck the step height on each side to ensure the crankshaft rear oil seal housing did not move. If the step height is beyond specification, reinstall the crankshaft rear oil seal housing and measure the step again. Replace the crankshaft rear oil seal housing if the clearance is still beyond specification.
12. Install the oil pan. Refer to [Oil Pan Replacement](#).
13. Install the engine flywheel. Refer to [Engine Flywheel Replacement](#).
14. Fill the cooling system. Refer to [Cooling System Draining and Filling \(Static Fill\)](#) or [Cooling System Draining and Filling \(Vac-N-Fill\)](#) .

## ENGINE REPLACEMENT

### Tools Required

- **J 38185** Hose Clamp Pliers. See [Special Tools](#).
- **J 37096** Flywheel Holding Tool. See [Special Tools](#).
- **J 45059** Angle Meter. See [Special Tools](#).

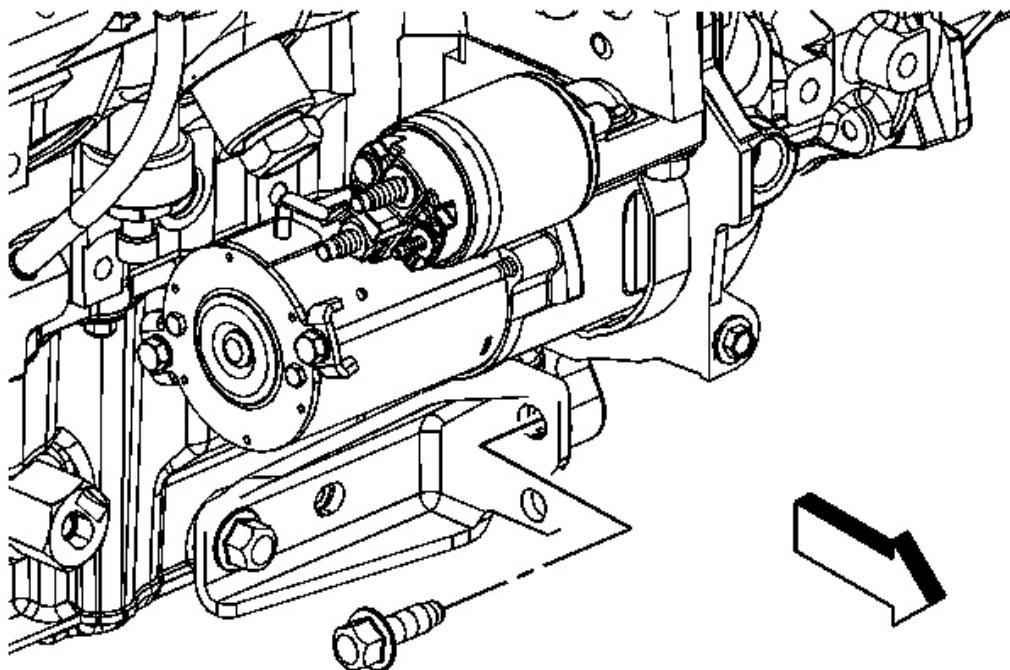
### Removal Procedure



**Fig. 240: View Of Intake Manifold Cover**

Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Remove the hood. Refer to **Hood Replacement** .
3. Clean the area around the oil fill tube.
4. Twist the oil fill tube counterclockwise in order to unlock the tube from the valve rocker cover.
5. Lift the front of the manifold cover up and slide the tab out of the engine bracket.
6. Replace the oil fill tube into the valve rocker cover.
7. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

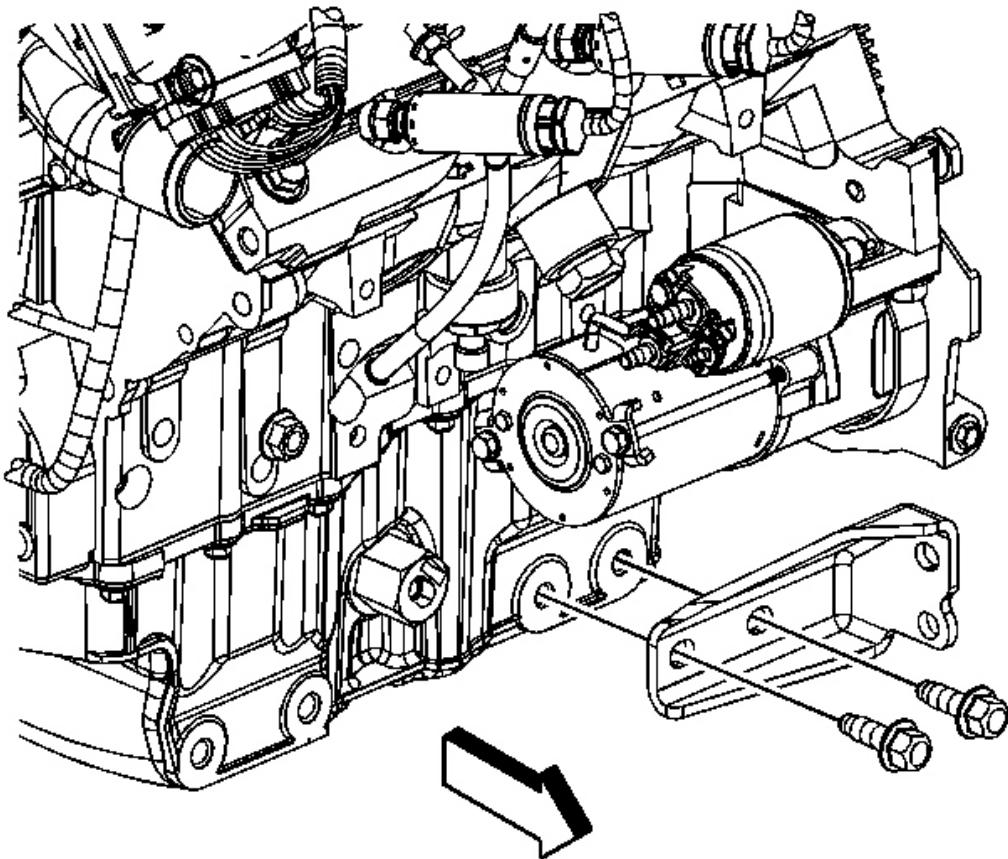


**Fig. 241: Identifying Transaxle Brace-To-Transaxle & Bolts**  
Courtesy of GENERAL MOTORS CORP.

8. Drain the engine oil. Refer to [Engine Oil and Oil Filter Replacement](#).
9. Drain the cooling system. Refer to [Cooling System Draining and Filling \(Static Fill\)](#) or [Cooling System Draining and Filling \(Vac-N-Fill\)](#) .
10. Remove the transaxle brace to transaxle bolts.

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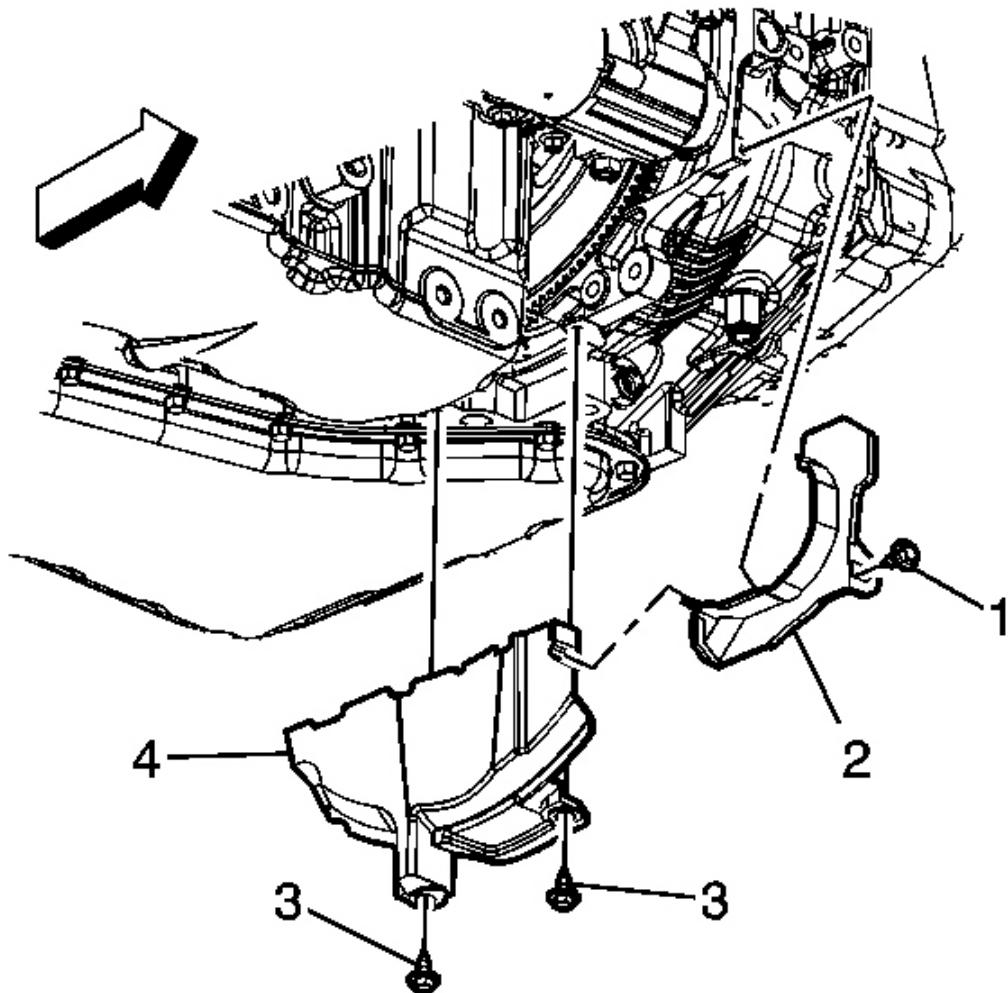
2006 ENGINE Engine Mechanical - 3.8L - Lucerne



**Fig. 242: Identifying Transaxle Brace & Bolts**

Courtesy of GENERAL MOTORS CORP.

11. Remove the transaxle brace to oil pan bolts and brace.

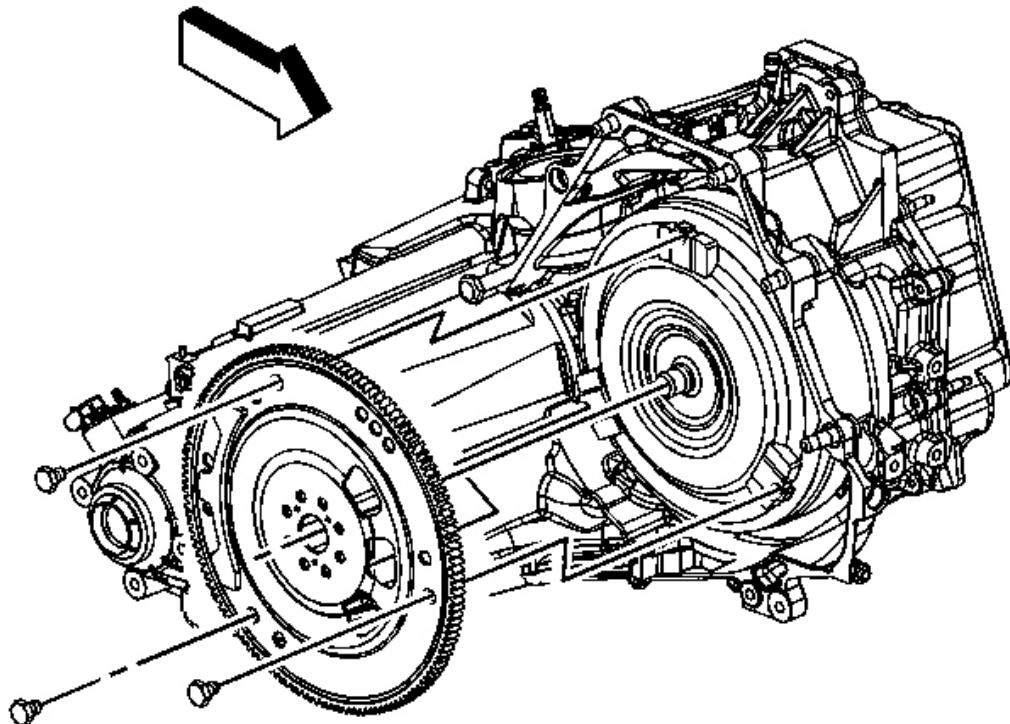


**Fig. 243: Identifying Transaxle Converter Cover**  
Courtesy of GENERAL MOTORS CORP.

12. Remove the front transaxle converter cover bolt (1).
13. Remove the front transaxle converter cover (2).
14. Remove the rear transaxle converter cover bolts (3).
15. Remove the rear transaxle converter cover (4).
16. Remove the starter motor. Refer to [Starter Motor Replacement \(RPO L26\)](#) or [Starter Motor Replacement \(RPO LD8\)](#).

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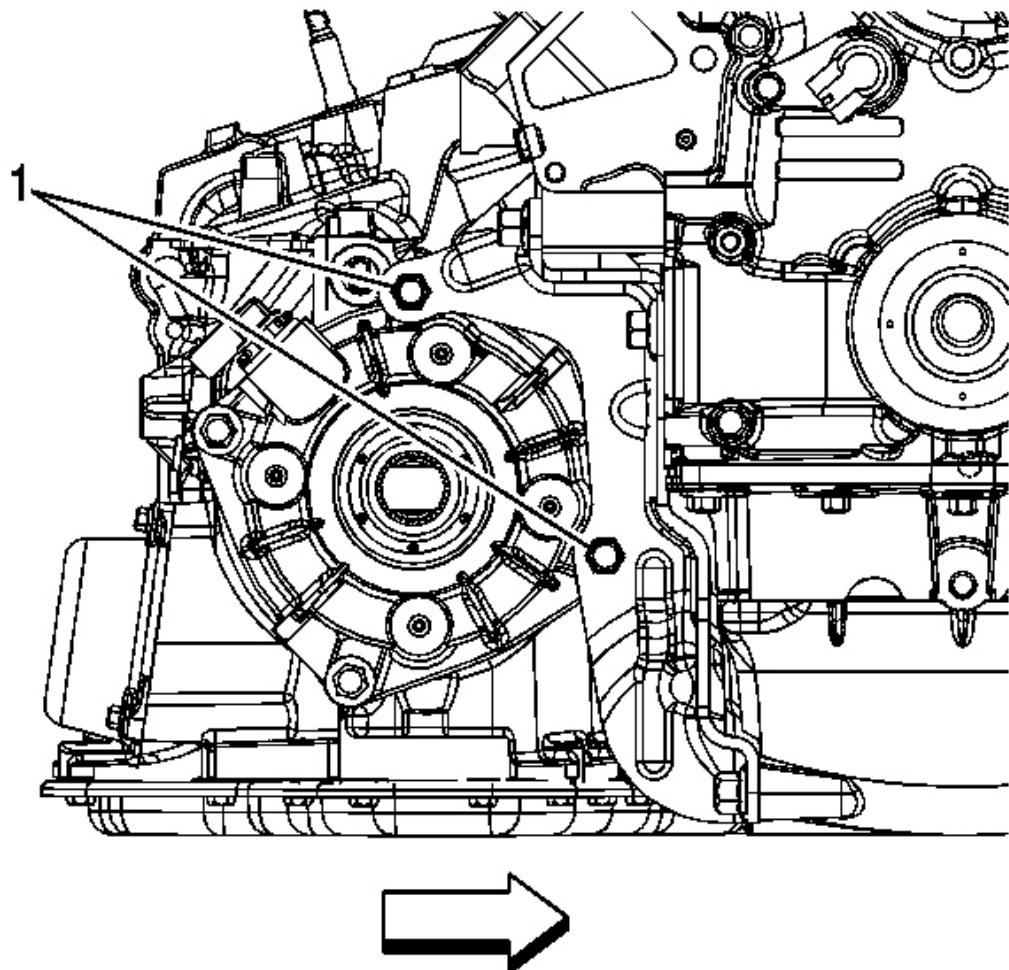
**Fig. 244: Identifying Torque Converter Bolts**

Courtesy of GENERAL MOTORS CORP.

17. Remove the torque converter bolts. (engine shown removed for clarity).
18. Mark the relationship of the torque converter to the flywheel for installation.

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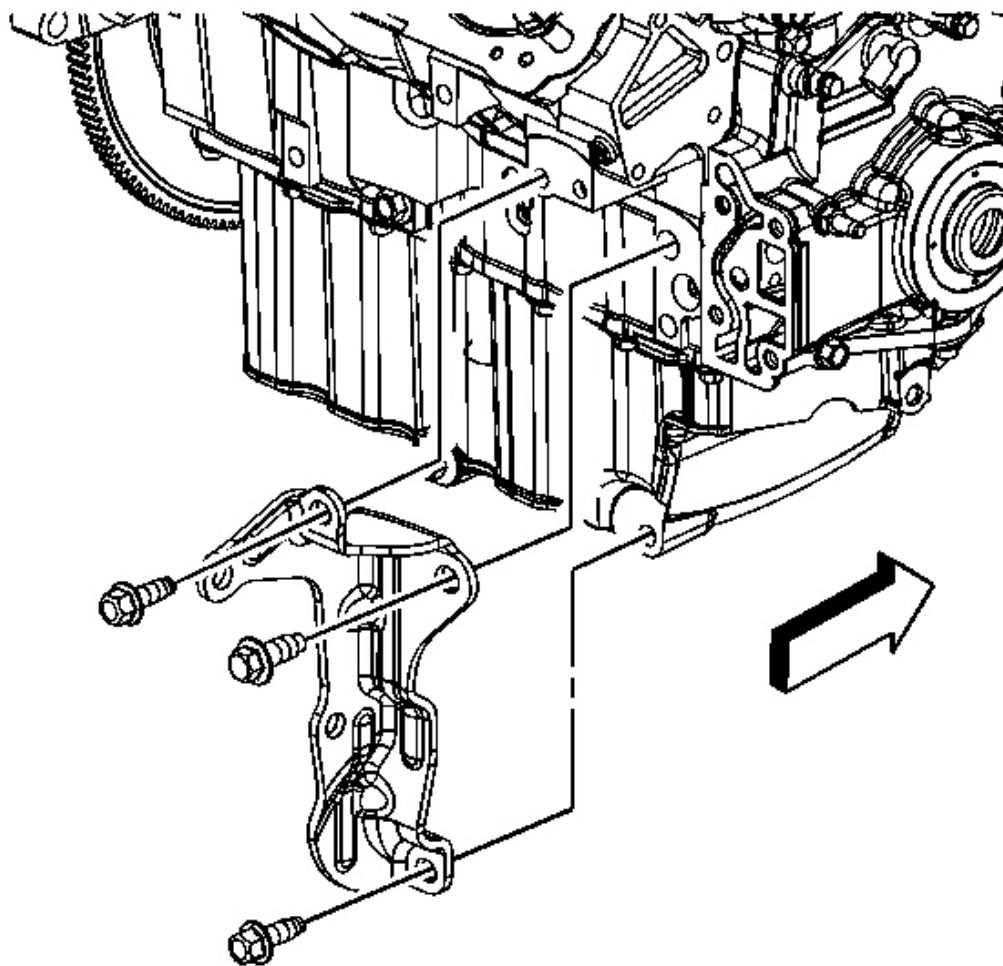


**Fig. 245: View Of Transaxle Brace-To-Transaxle Bolts**  
Courtesy of GENERAL MOTORS CORP.

19. Remove the transaxle brace to transaxle bolts (1).

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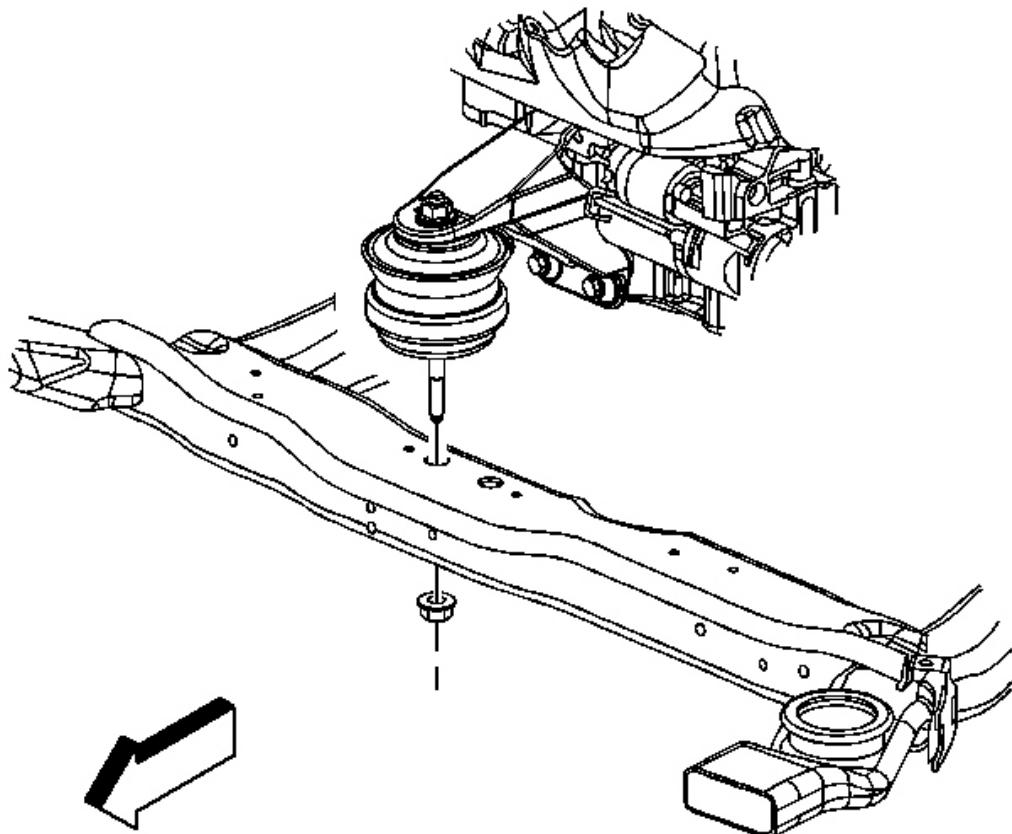
**Fig. 246: Identifying Transaxle Brace-To-Oil Pan & Bolts**

Courtesy of GENERAL MOTORS CORP.

20. Remove the transaxle brace to engine and oil pan bolts and brace.

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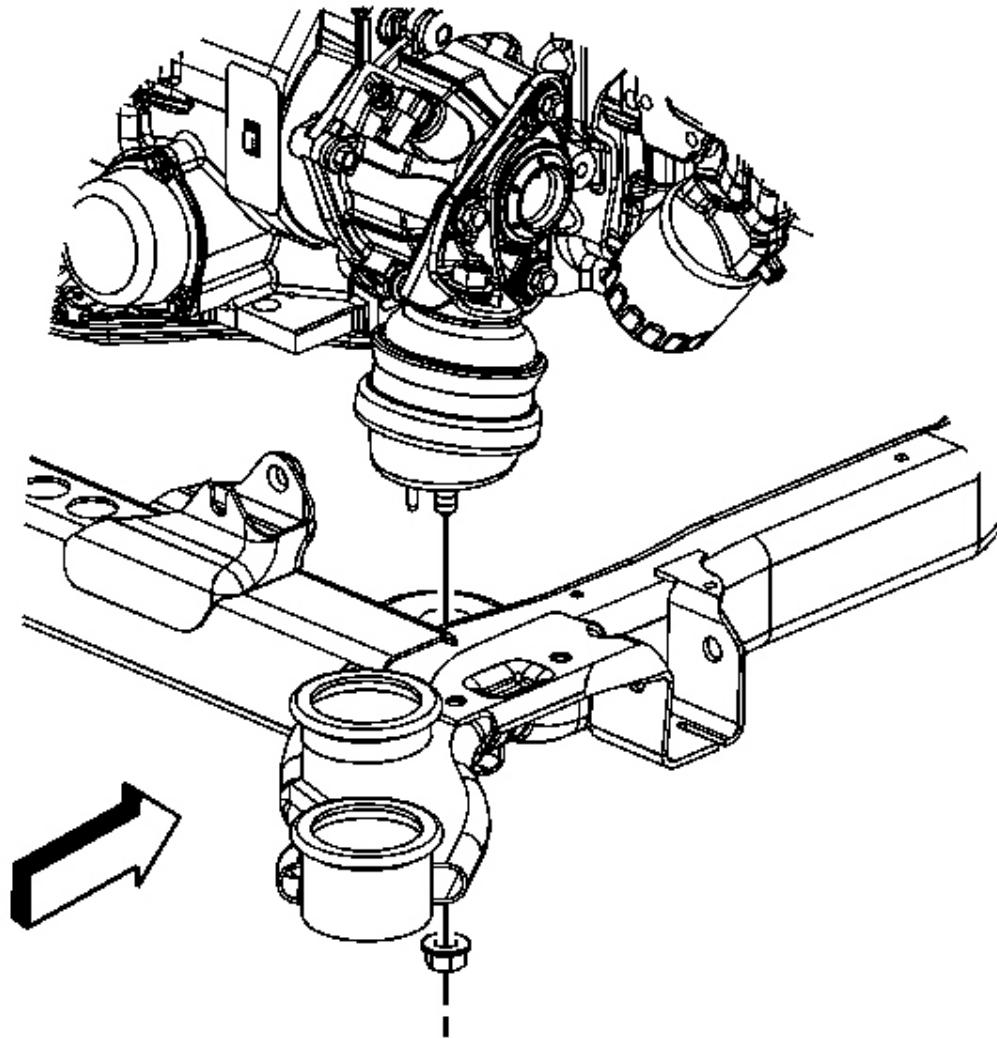
**Fig. 247: Identifying Engine Front Mount-To-Frame Nut**

Courtesy of GENERAL MOTORS CORP.

21. Remove the front engine mount to frame nut.

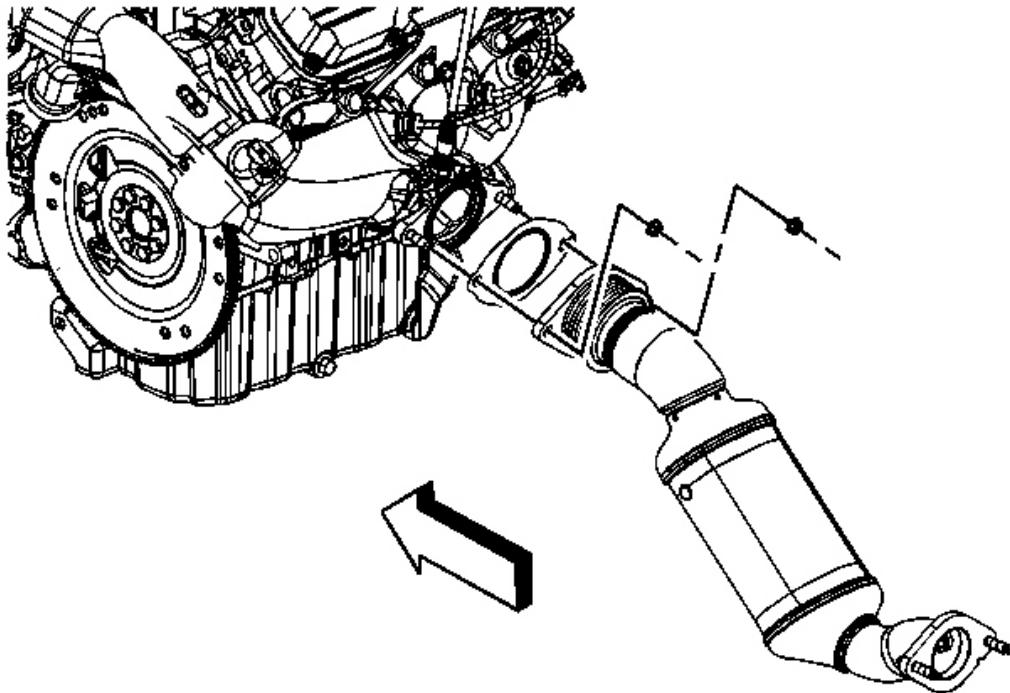
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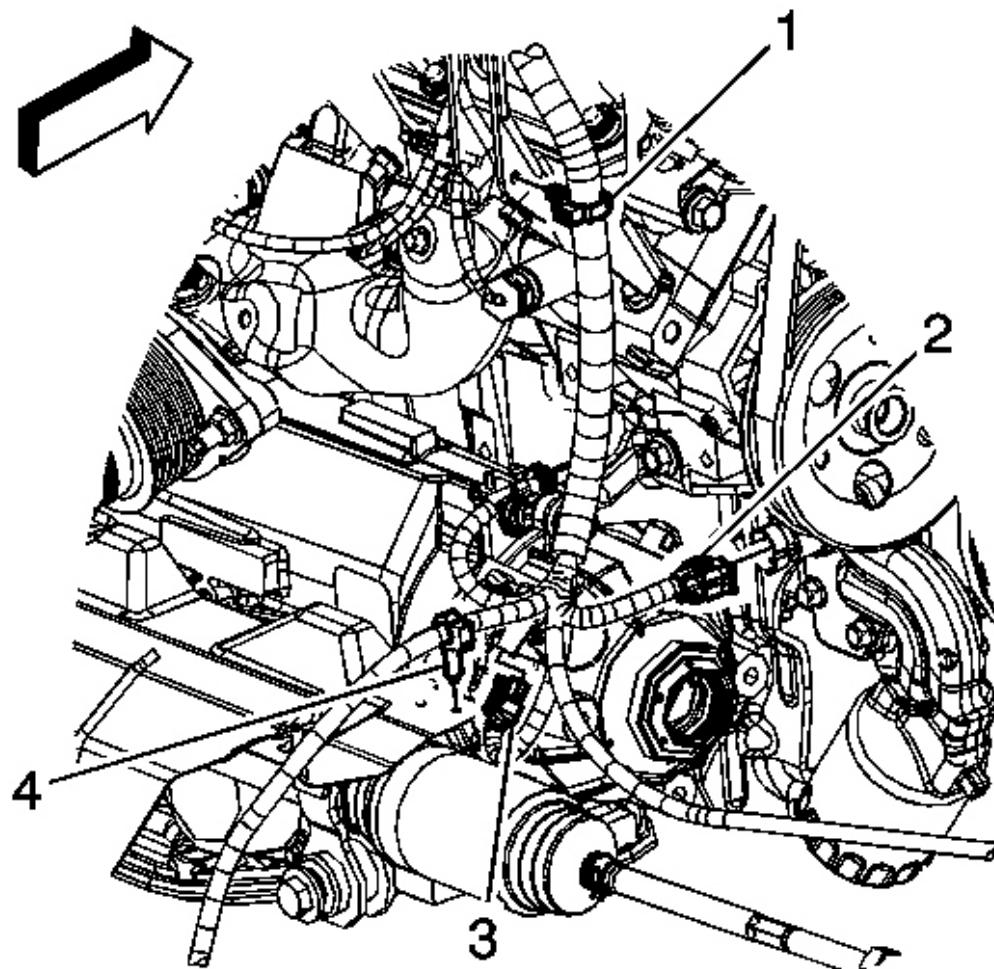
**Fig. 248: Identifying Engine Rear Mount To Frame Nut**  
Courtesy of GENERAL MOTORS CORP.

22. Remove the rear engine mount to frame nut.



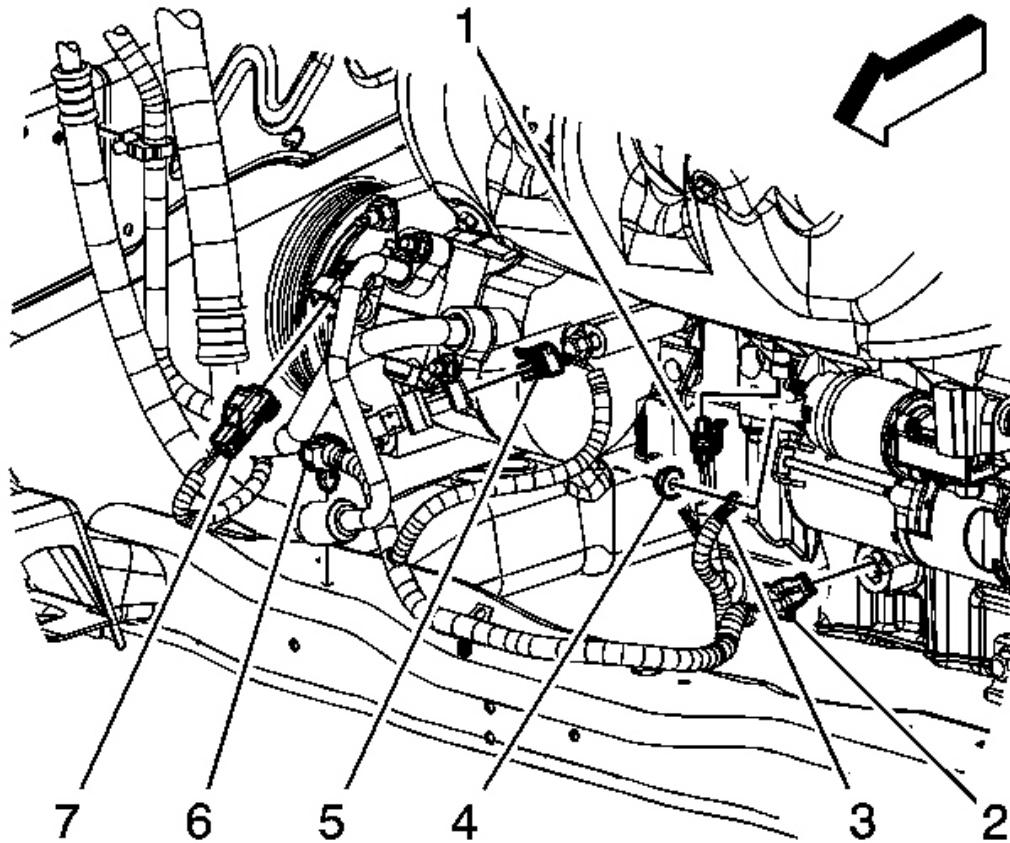
**Fig. 249: View Of Catalytic Converter-To-Exhaust Manifold Nuts**  
Courtesy of GENERAL MOTORS CORP.

23. Remove the exhaust manifold to catalytic converter nuts.



**Fig. 250: View Of Left Side Engine Compartment Components**  
Courtesy of GENERAL MOTORS CORP.

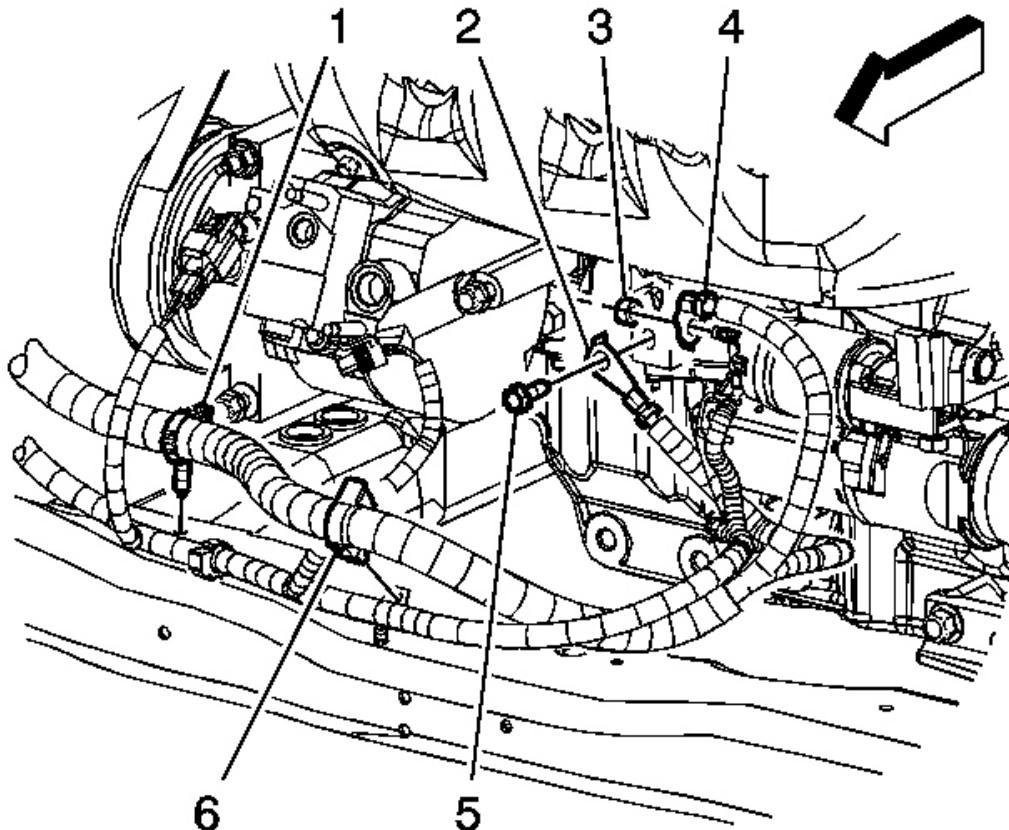
24. Disconnect the engine harness electrical connector (2) from the oil pressure sensor.
25. Disconnect the engine harness electrical connector (3) from the vehicle speed sensor (VSS).
26. Remove the engine harness clip (1) from the engine bracket.
27. Remove the engine harness clip (4) from the steering gear bracket.
28. Disconnect the engine harness electrical connector from the rear knock sensor jumper harness.



**Fig. 251: View Of Engine Harness Electrical Connectors**

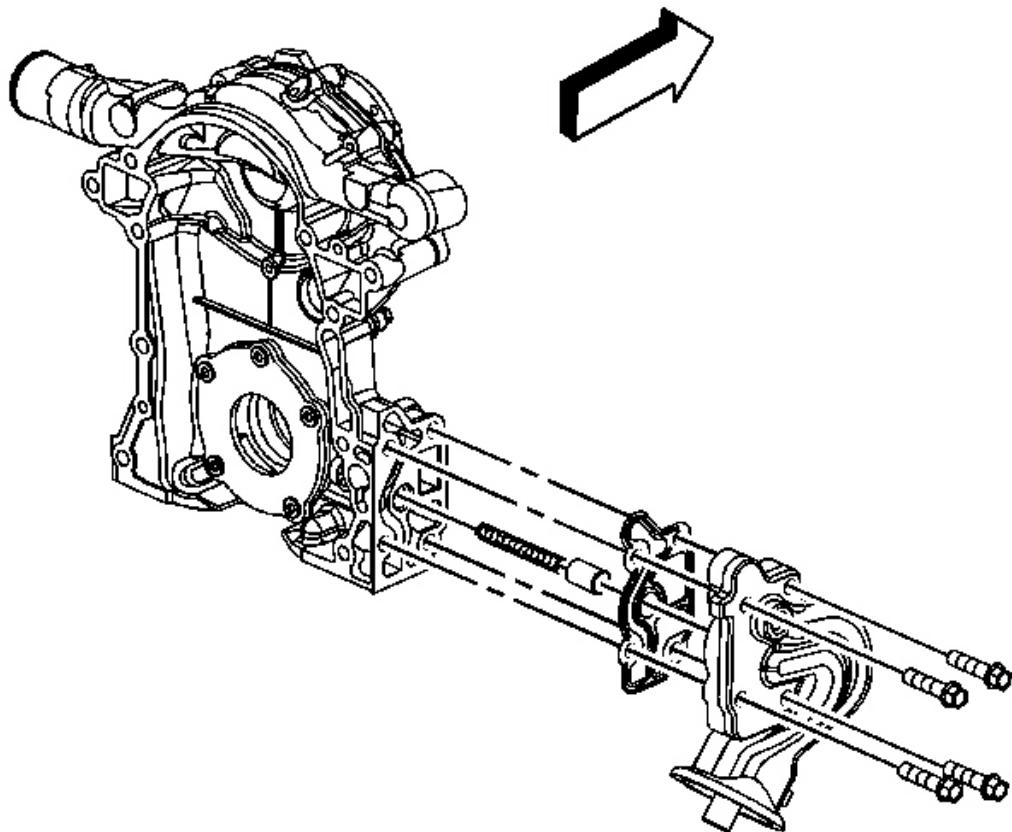
Courtesy of GENERAL MOTORS CORP.

29. Disconnect the engine harness electrical connector (1) from the front knock sensor.
30. Disconnect the engine harness electrical connector (2) from the oil level sensor.
31. Disconnect the engine harness electrical connector (5) from the air conditioning (A/C) pressure sensor.
32. Disconnect the engine harness electrical connector (7) from the A/C compressor.



**Fig. 252: Identifying Starter Solenoid & Starter Motor Cable Terminals**  
Courtesy of GENERAL MOTORS CORP.

33. Remove the starter cable ground bolt (5) and reposition the starter cable terminal (2) from the engine.



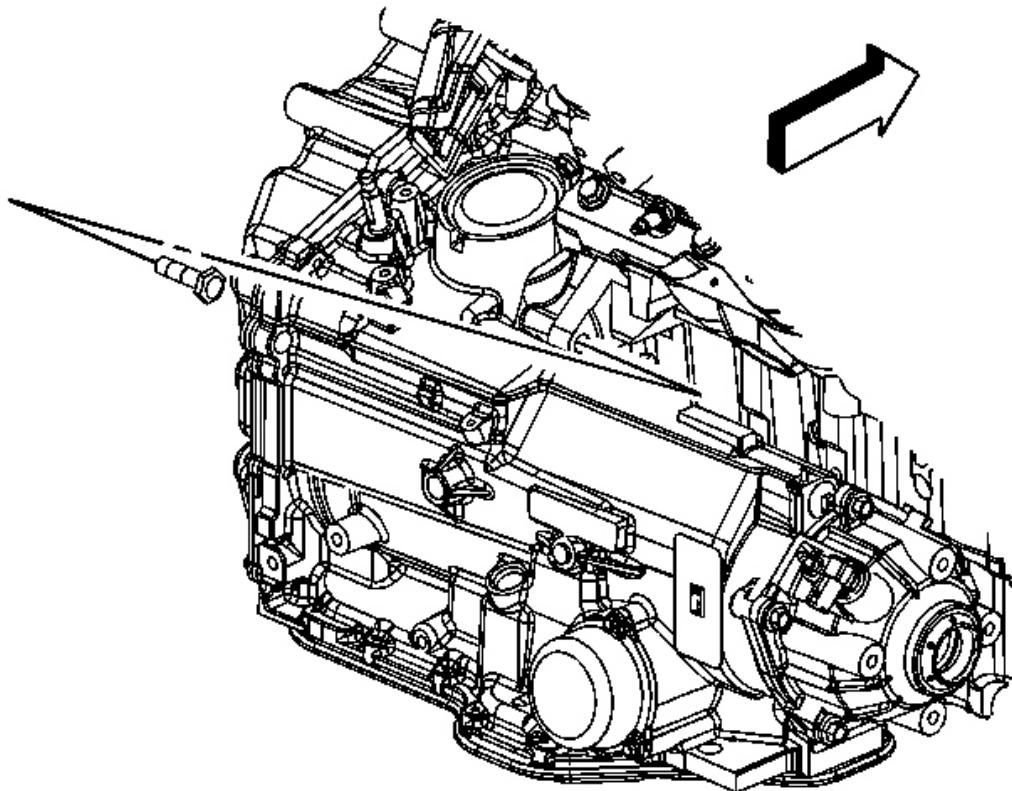
**Fig. 253: Identifying Oil Filter Adapter & Bolts**

Courtesy of GENERAL MOTORS CORP.

34. Remove the right wheel drive shaft. Refer to [Wheel Drive Shaft Replacement](#) .
35. Remove the oil filter adapter bolts.
36. Remove the oil filter adapter and gasket.

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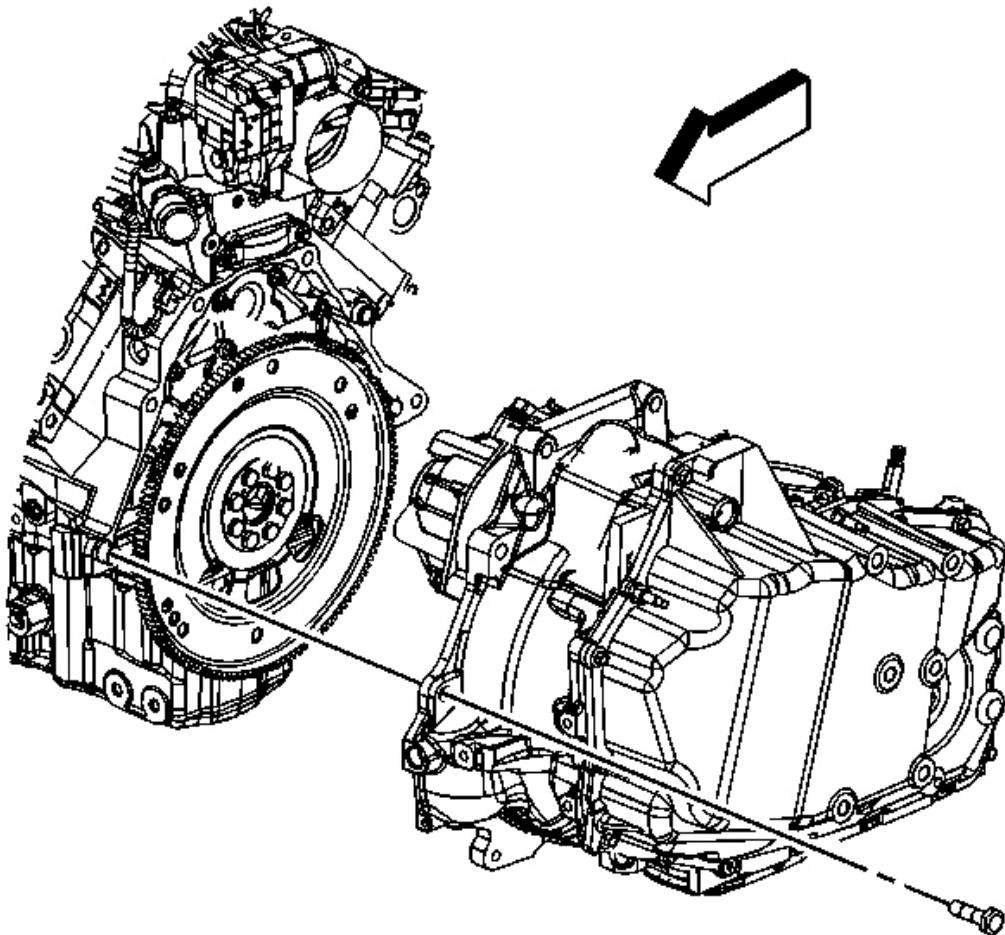


**Fig. 254: View Of Transaxle**  
Courtesy of GENERAL MOTORS CORP.

37. Remove the lower rear transaxle bolt.

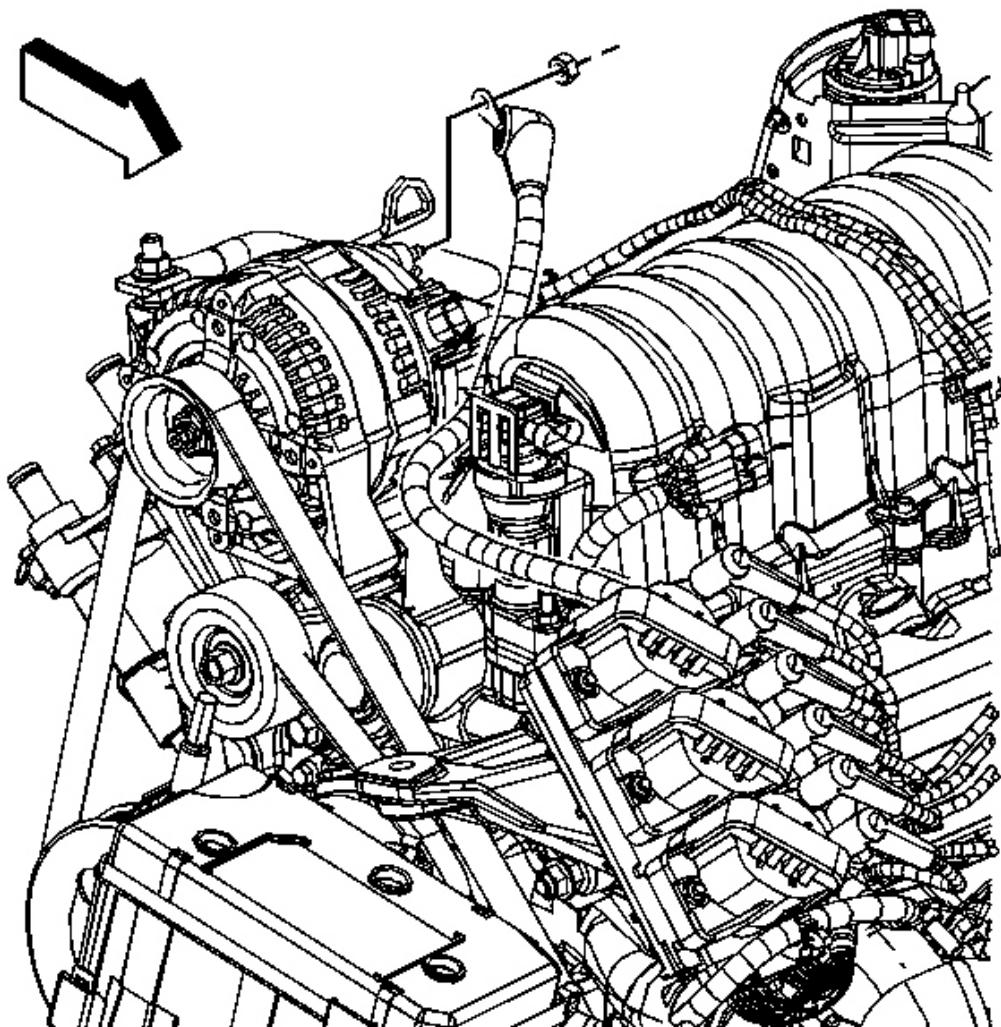
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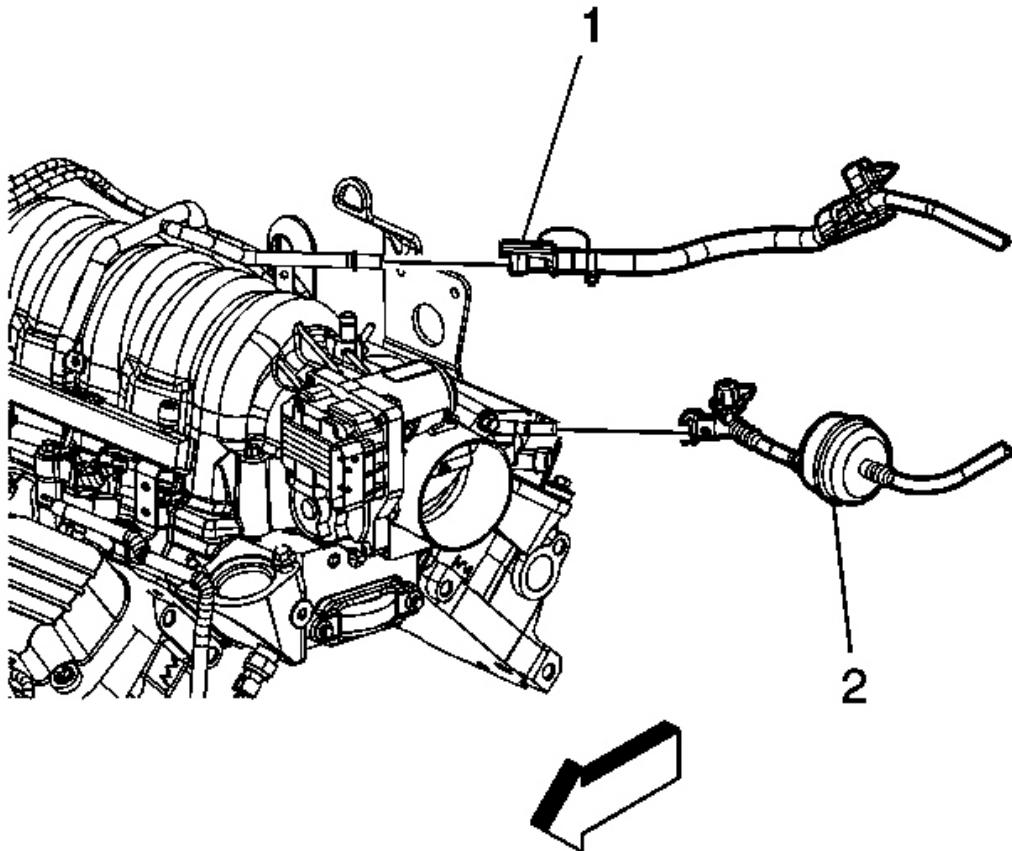
**Fig. 255: Identifying Lower Front Transaxle Bolt**  
Courtesy of GENERAL MOTORS CORP.

38. Remove the lower front transaxle bolt.
39. Lower the vehicle while supporting the transaxle.
40. Remove the air cleaner assembly. Refer to [Air Cleaner Assembly Replacement](#) .



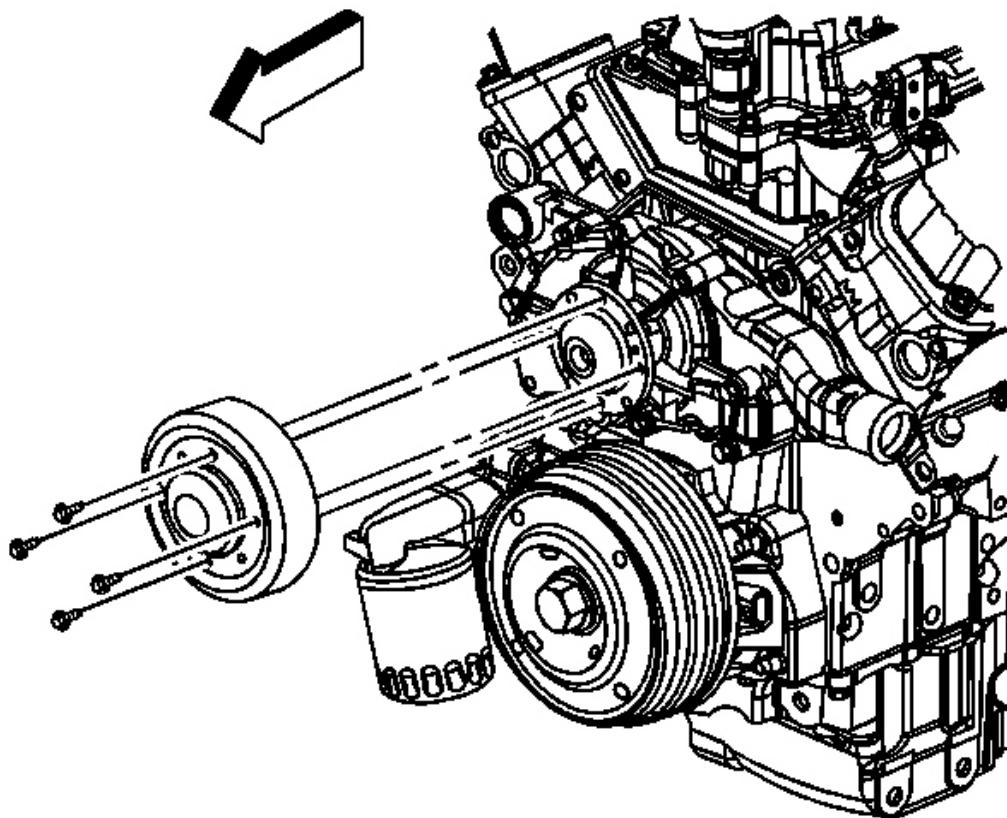
**Fig. 256: Identifying Generator Terminal Nut**  
Courtesy of GENERAL MOTORS CORP.

41. Reposition the starter cable boot.
42. Remove the generator terminal nut.
43. Remove the starter cable from the generator.



**Fig. 257: Locating Evaporative Emission (EVAP) Pipe Quick Connect Fitting**  
Courtesy of GENERAL MOTORS CORP.

44. Disconnect the fuel feed line (1) quick connect fitting from the fuel rail. Refer to [Metal Collar Quick Connect Fitting Service](#) .
45. Disconnect the evaporative emission (EVAP) line (2) quick connect fitting from the purge solenoid. Refer to [Plastic Collar Quick Connect Fitting Service](#) .

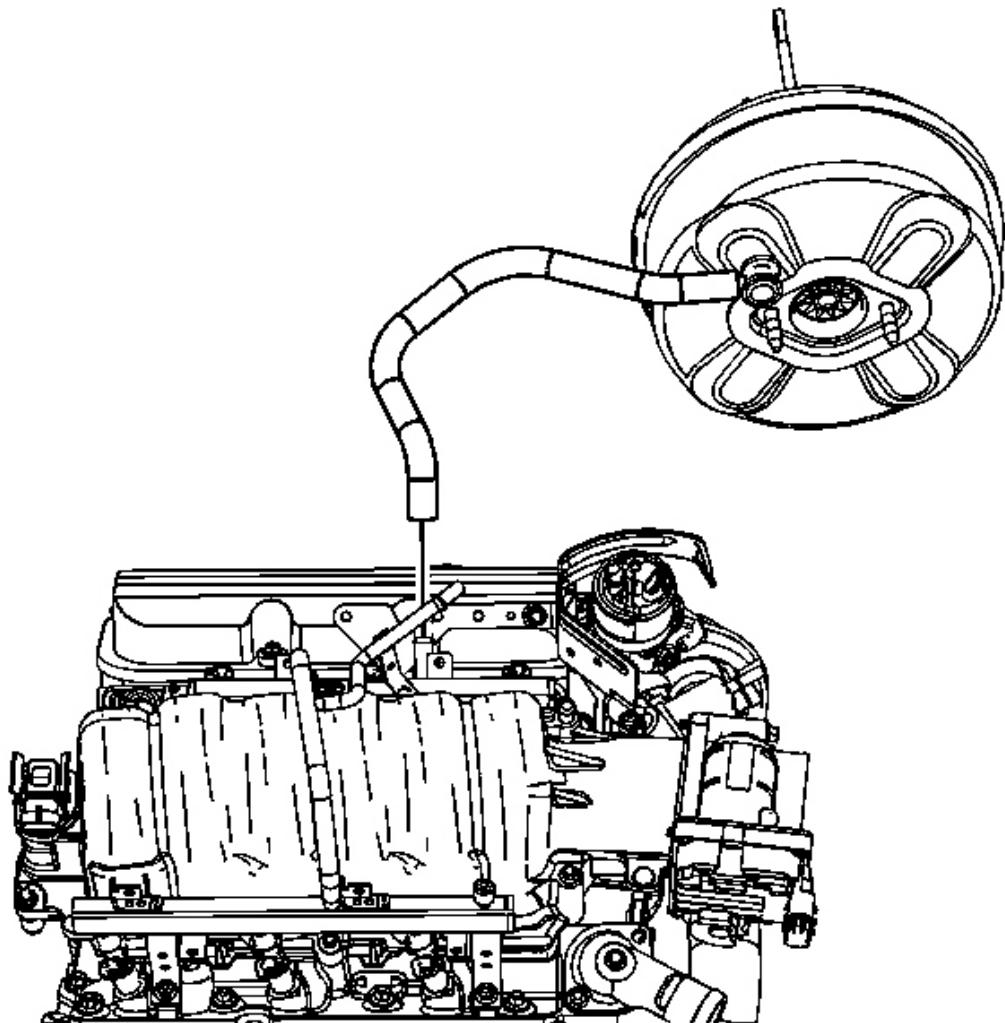


**Fig. 258: Identifying Water Pump Pulley & Bolts**  
Courtesy of GENERAL MOTORS CORP.

46. Loosen the water pump pulley bolts.
47. Remove the drive belt. Refer to [Drive Belt Replacement](#).
48. Remove the water pump pulley bolts and water pump pulley.
49. Remove the engine mount strut. Refer to [Engine Mount Strut Replacement](#).
50. Remove the fan shroud. Refer to [Fan Shroud Replacement \(L26\)](#) or [Fan Shroud Replacement \(LD8\)](#).

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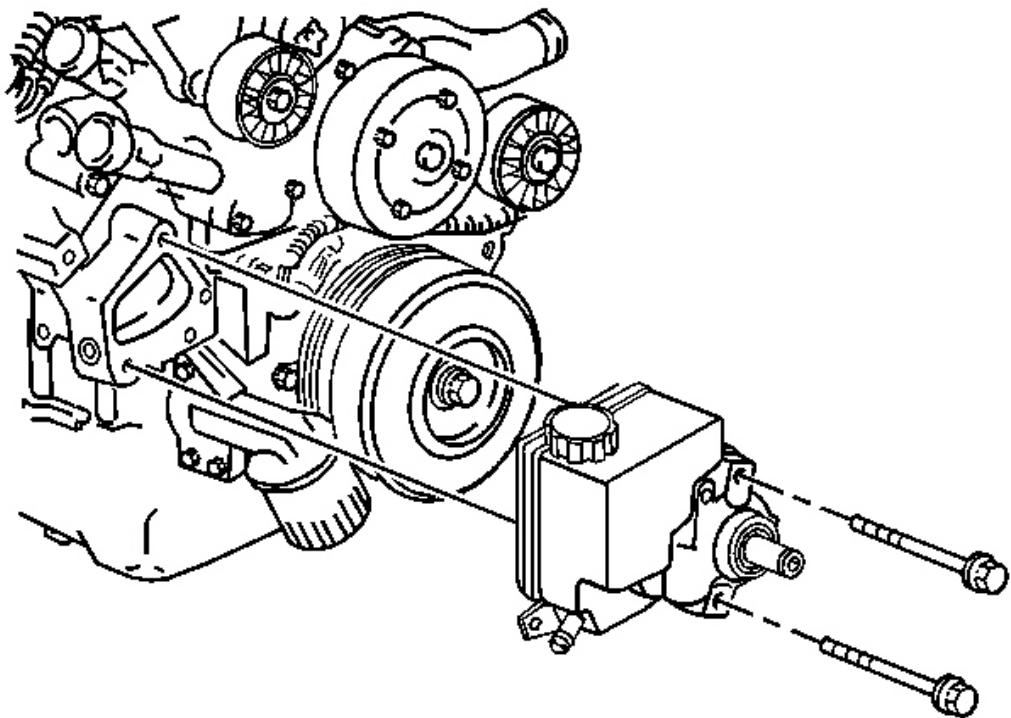
2006 ENGINE Engine Mechanical - 3.8L - Lucerne



**Fig. 259: View Of Brake Booster Vacuum Hose**

**Courtesy of GENERAL MOTORS CORP.**

51. Remove the brake booster vacuum hose from the intake manifold.

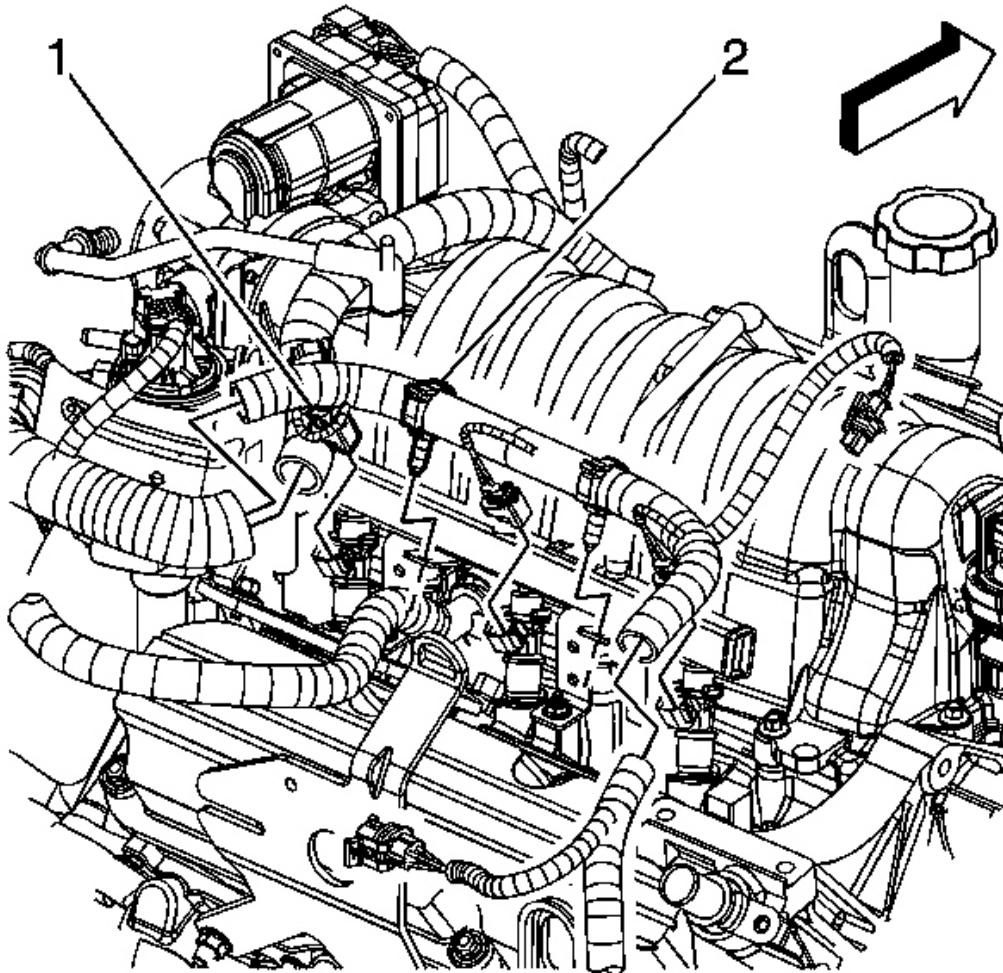


**Fig. 260: View Of Power Steering Pump And Mounting Bolts**  
Courtesy of GENERAL MOTORS CORP.

52. Remove the power steering pump bolts. Lay the power steering pump aside. (pulley shown removed for clarity).

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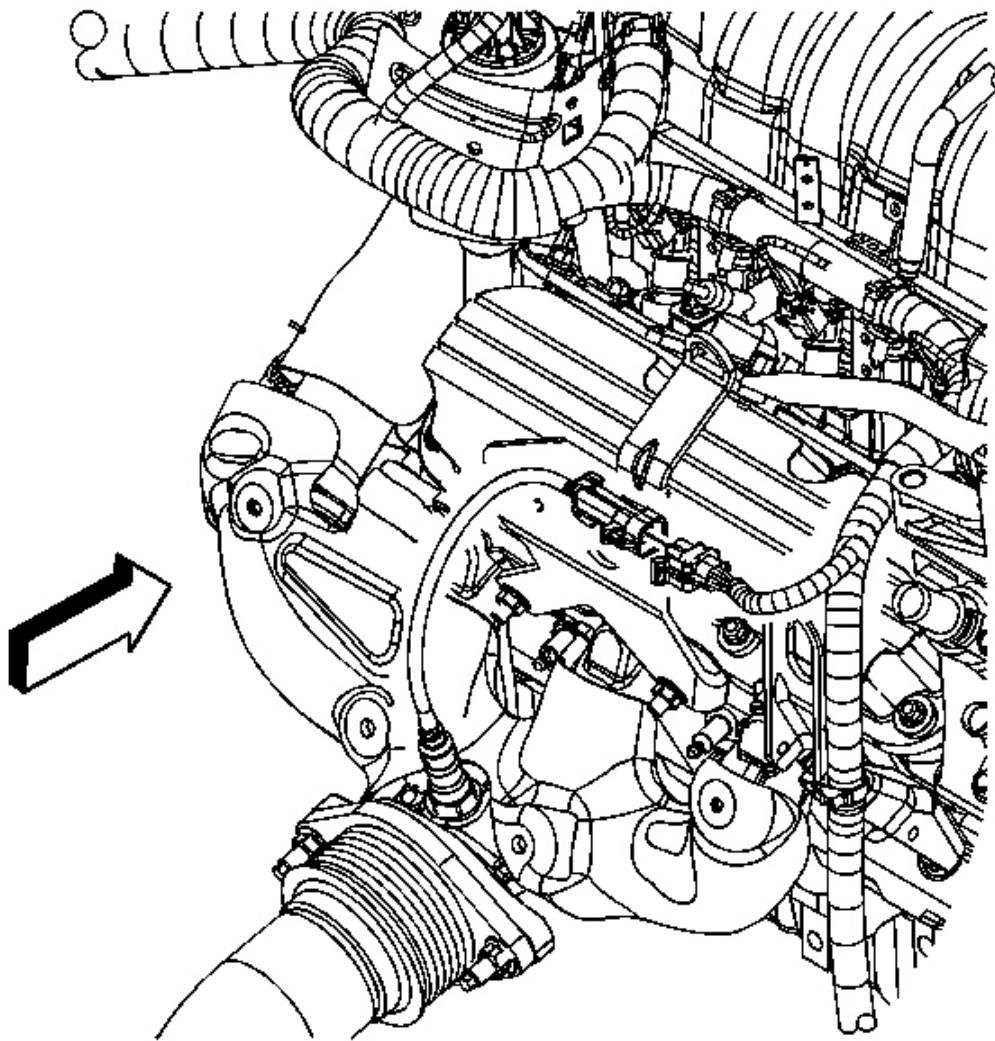
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**Fig. 261: Locating Engine Harness Electrical Connectors**

Courtesy of GENERAL MOTORS CORP.

53. Disconnect the engine harness electrical connectors (1) from the rear fuel injectors.
54. Remove the engine harness electrical connector retainers (2) from the fuel rail.



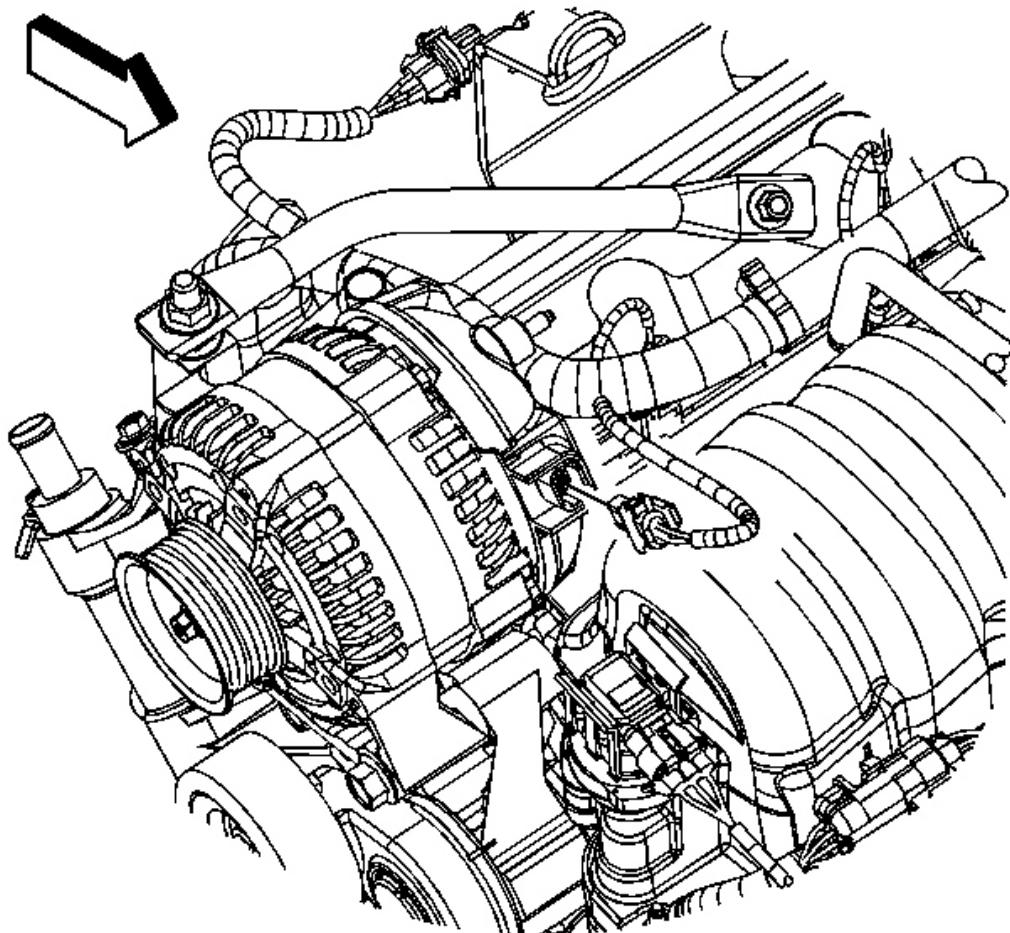
**Fig. 262: View Of Right Side Exhaust Manifold & Rear Heated Oxygen Sensor (HO2S)**

Courtesy of GENERAL MOTORS CORP.

55. Disconnect the engine harness electrical connector from the rear heated oxygen sensor (HO2S).

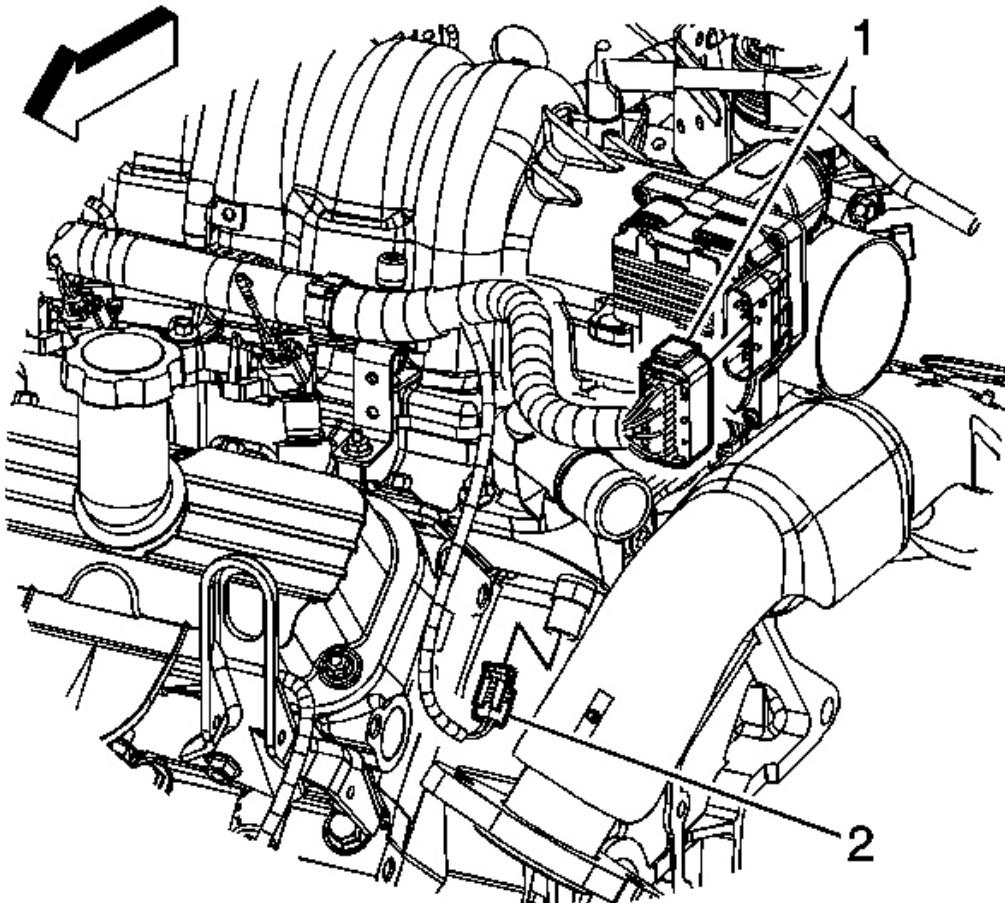
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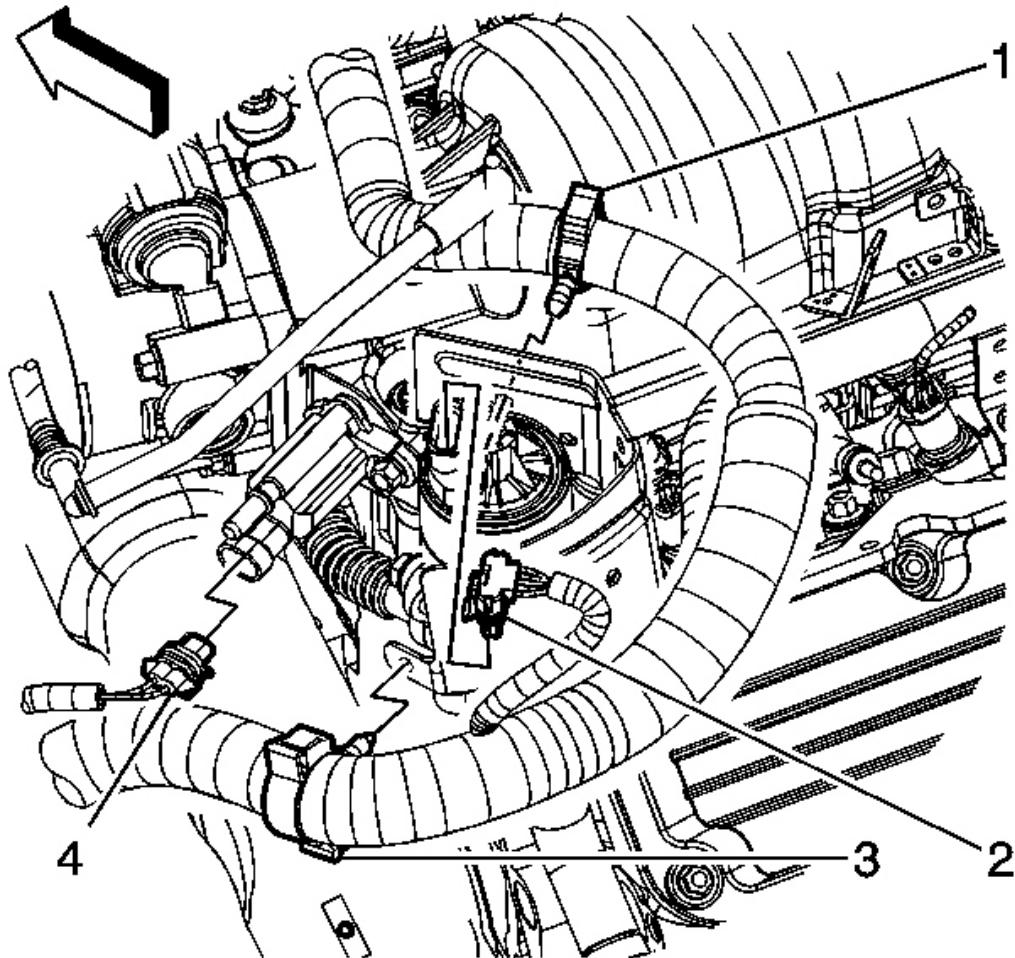
**Fig. 263: Identifying Generator Harness Electrical Connector**  
Courtesy of GENERAL MOTORS CORP.

56. Disconnect the engine harness electrical connector from the generator.



**Fig. 264: Identifying Throttle Actuator Harness Connector**  
Courtesy of GENERAL MOTORS CORP.

57. Disconnect the engine harness electrical connector (1) from the throttle actuator.
58. Disconnect the engine harness electrical connector (2) from the engine coolant temperature (ECT) sensor.

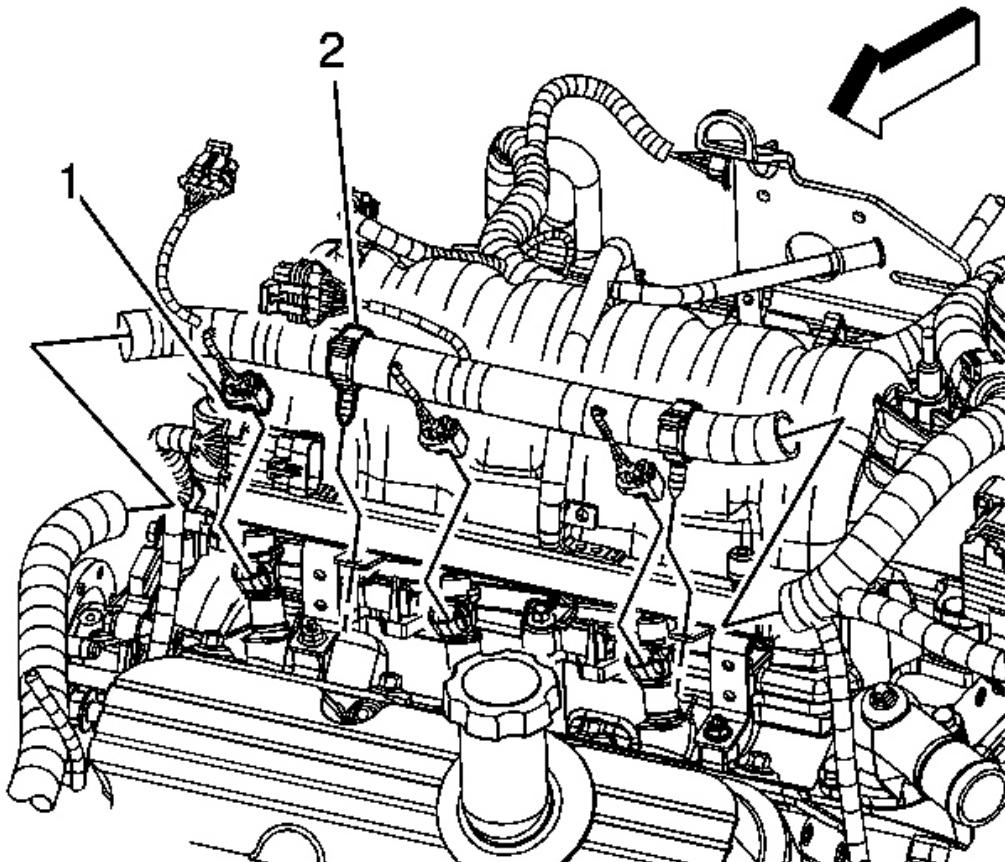


**Fig. 265: Identifying Engine Harness Clips**  
Courtesy of GENERAL MOTORS CORP.

59. Disconnect the engine harness clips (1, 3) from the heat shield.
60. Disconnect the engine harness electrical connector (2) from the exhaust gas recirculation (EGR) valve.

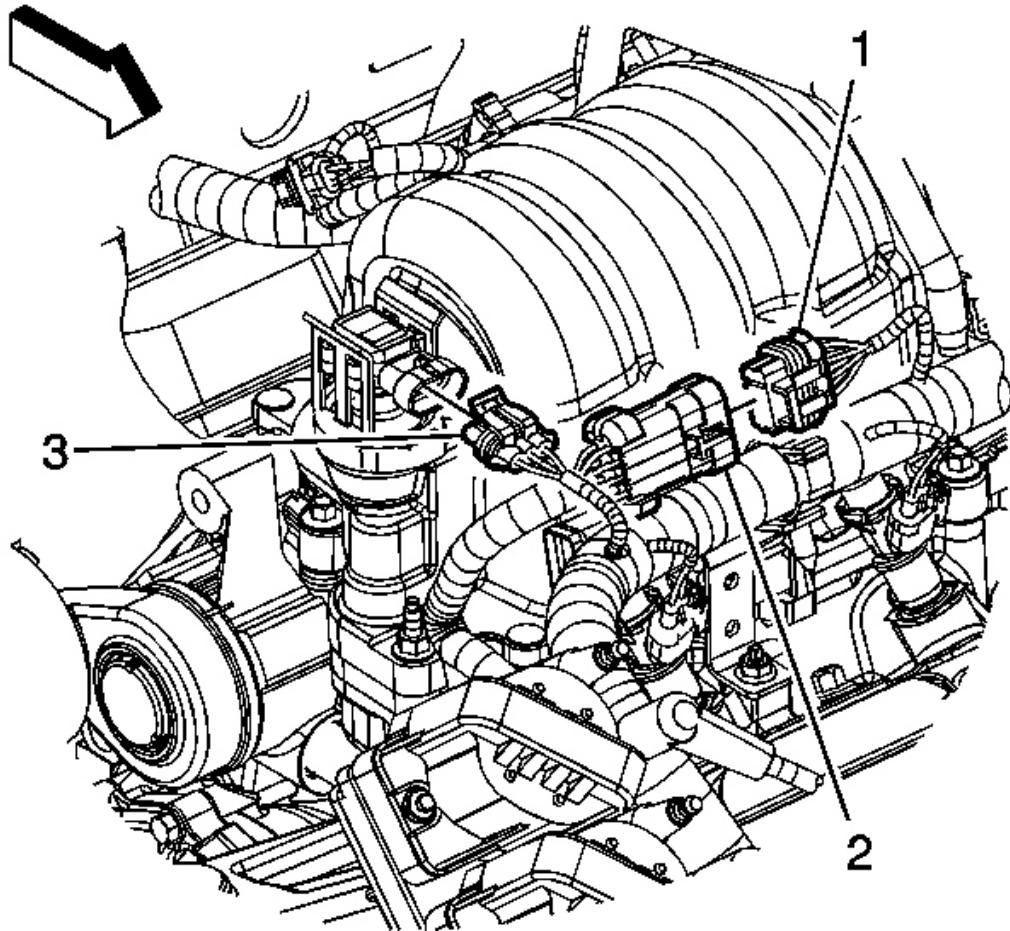
## 2006 Buick Lucerne CXS

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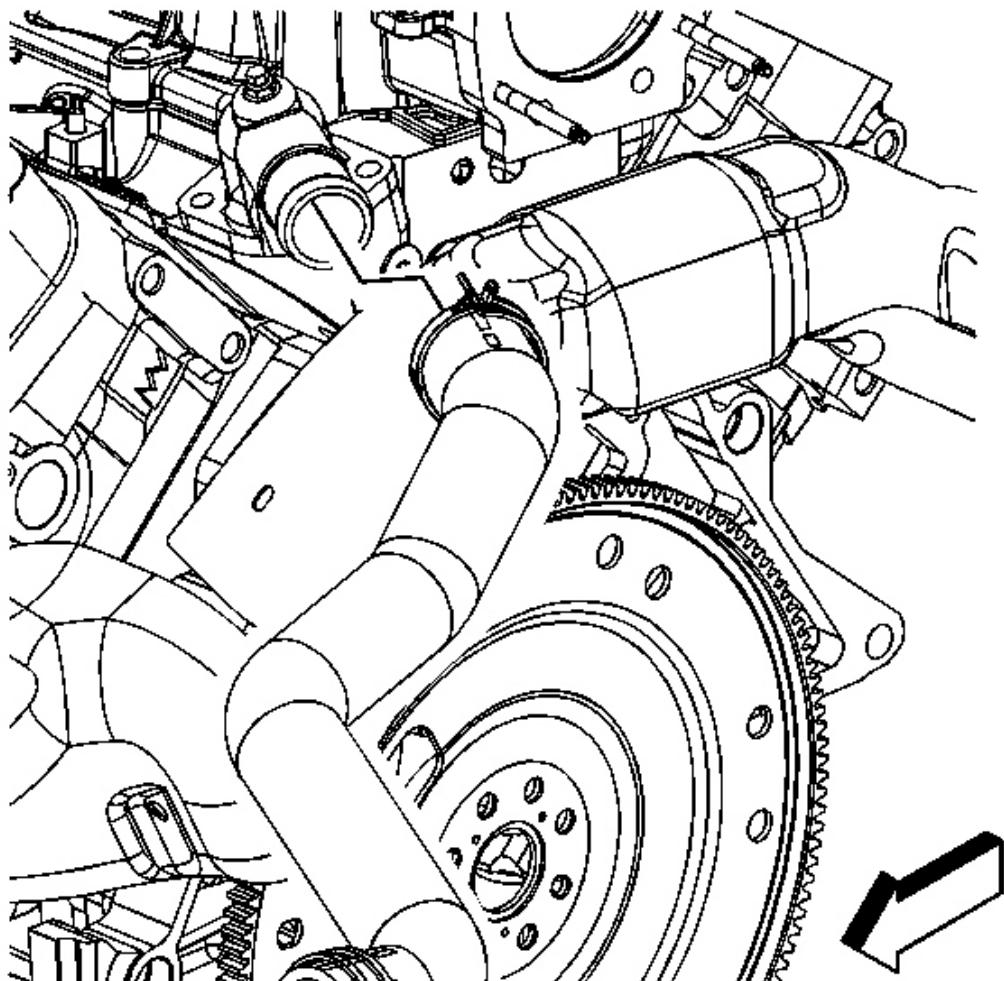
**Fig. 266: Identifying Engine Harness Connectors**  
Courtesy of GENERAL MOTORS CORP.

61. Disconnect the engine harness electrical connectors (1) from the front fuel injectors.
62. Remove the engine harness retainers (2) from the fuel rail.



**Fig. 267: Identifying Engine Control Module Harness Connectors**  
Courtesy of GENERAL MOTORS CORP.

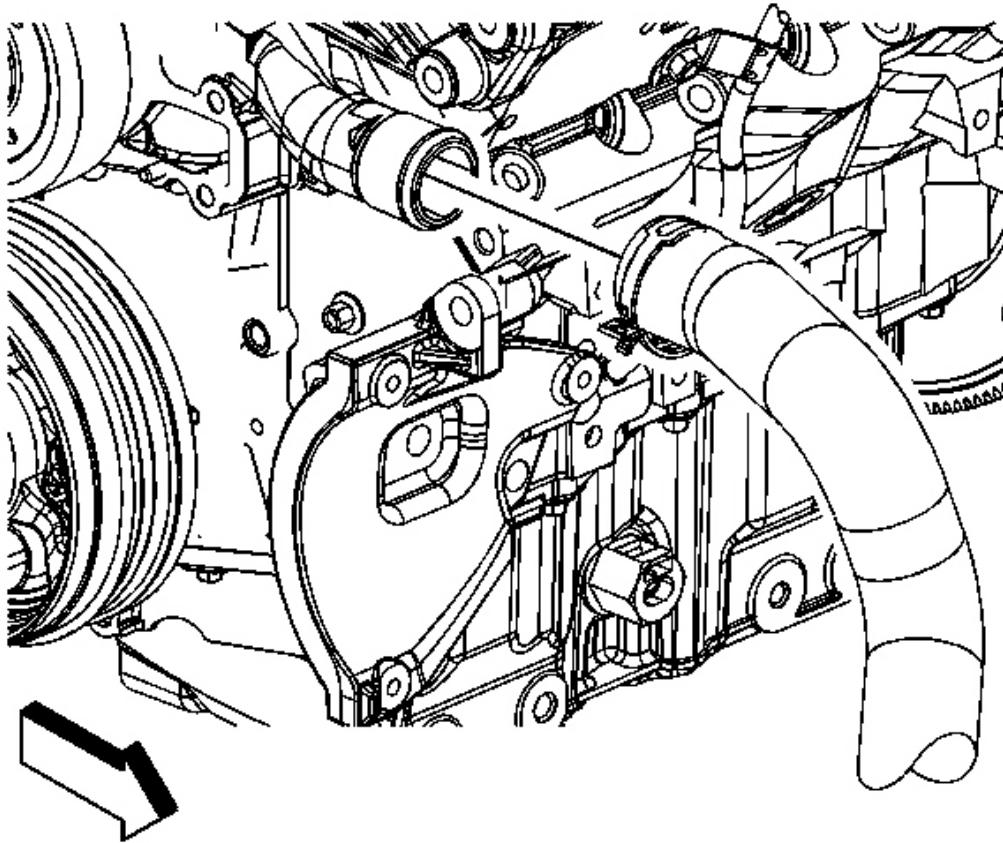
63. Disconnect the engine harness electrical connector (1) from the ignition control module harness electrical connector (2).
64. Disconnect the engine harness electrical connector (3) from the manifold absolute pressure (MAP) sensor.
65. Gather all branches of the engine wiring harness and reposition the harness out of the way.



**Fig. 268: Locating Inlet Hose Clamps**

Courtesy of GENERAL MOTORS CORP.

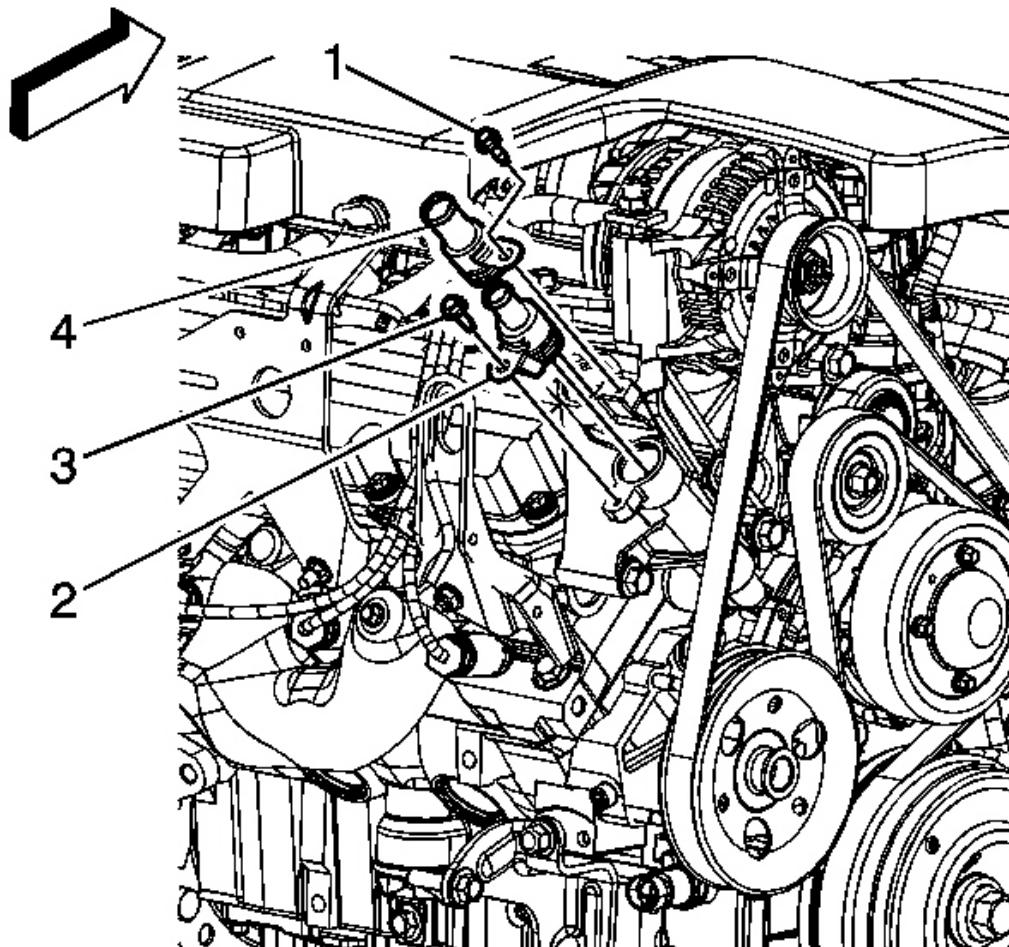
66. Using **J 38185** reposition the radiator inlet hose clamp at the thermostat housing. See **Special Tools**.
67. Remove the radiator inlet hose from the thermostat housing.



**Fig. 269: Identifying Radiator Outlet Hose**

Courtesy of GENERAL MOTORS CORP.

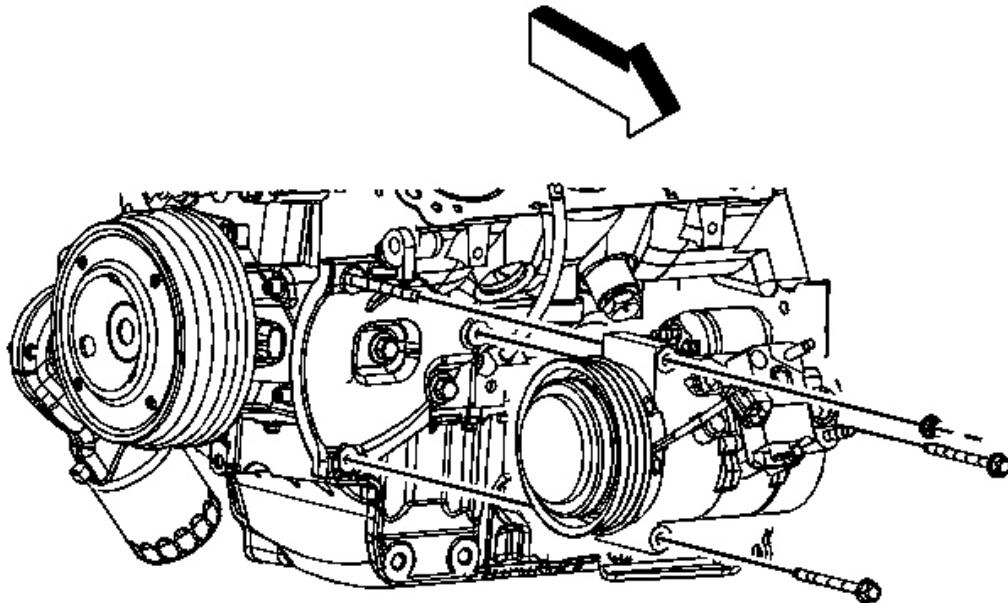
68. Using **J 38185** reposition the radiator outlet hose clamp at the front cover. See [Special Tools](#).
69. Remove the radiator outlet hose from the front cover.



**Fig. 270: Identifying Hose Adapter Bolts**

Courtesy of GENERAL MOTORS CORP.

70. Remove the heater inlet and outlet hose adapter bolts (1, 3). (heater hoses shown removed for clarity).
71. Remove the heater inlet (4) and outlet (2) adapters from the drive belt tensioner.



**Fig. 271: Identifying A/C Compressor & Mounting Bolts**

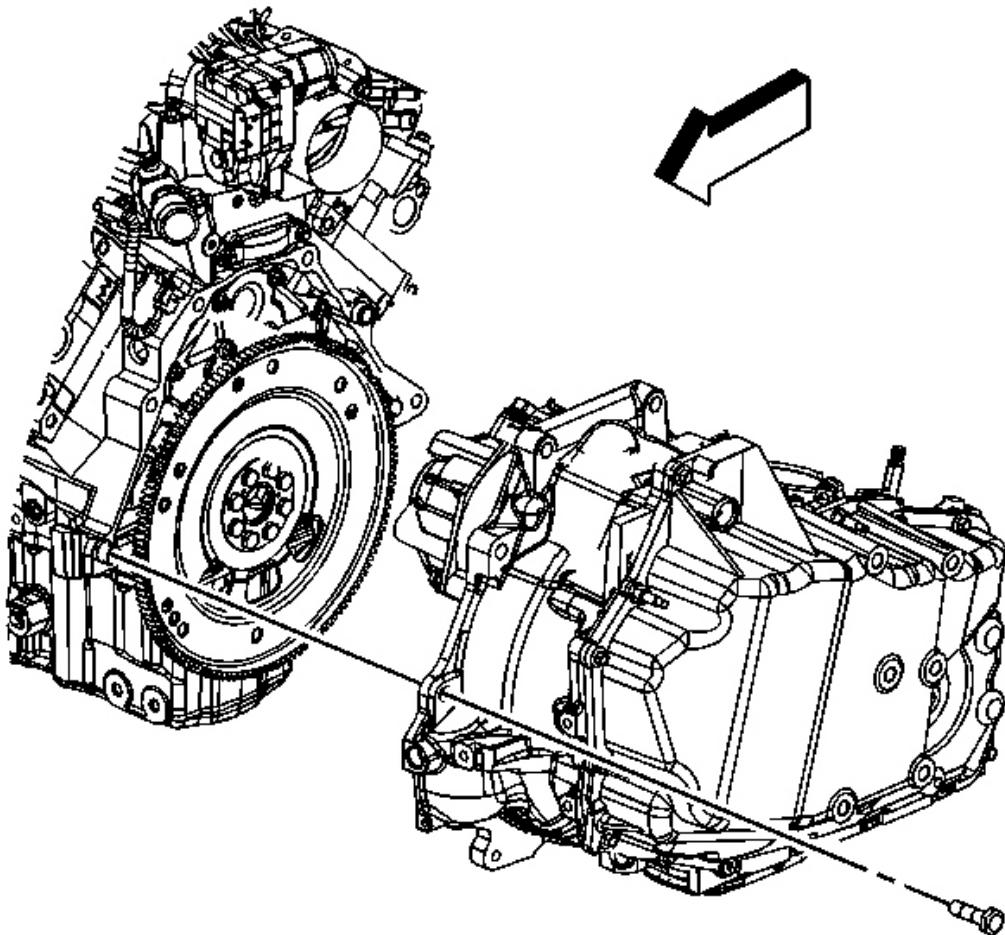
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT: It is not necessary to recover the A/C system.**

72. Remove the A/C compressor bolts and nut. DO NOT discharge the A/C system.
73. Reposition and secure the A/C compressor to the frame.
74. Install a engine lifting device to the lift brackets.

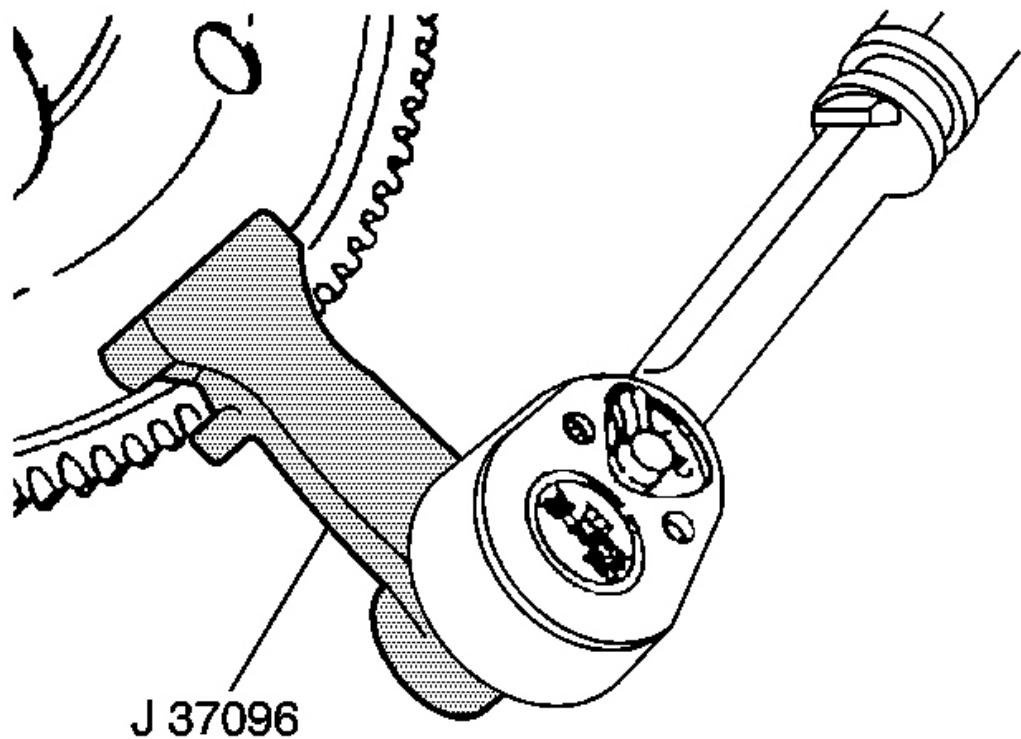
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**Fig. 272: Identifying Upper Transaxle Bolts**  
Courtesy of GENERAL MOTORS CORP.

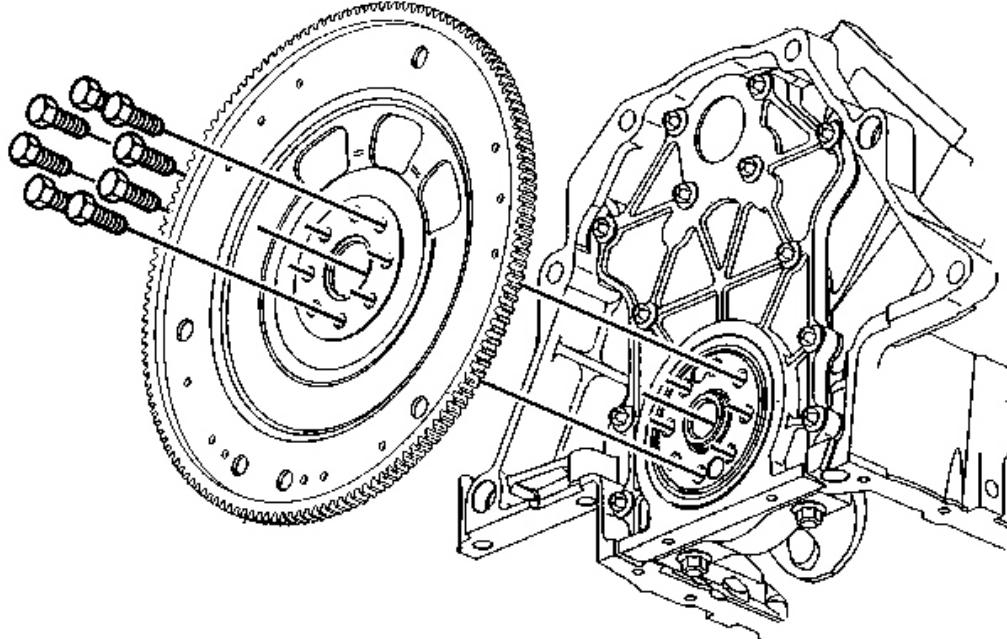
75. Remove the upper transaxle bolts.
76. With the aid of an assistant, remove the engine from the vehicle.



**Fig. 273: Holding Flywheel**

Courtesy of GENERAL MOTORS CORP.

77. Install the **J 37096** to a ratchet. See **Special Tools**.
78. Install the **J 37096** and ratchet to the flywheel to hold the flywheel. See **Special Tools**.

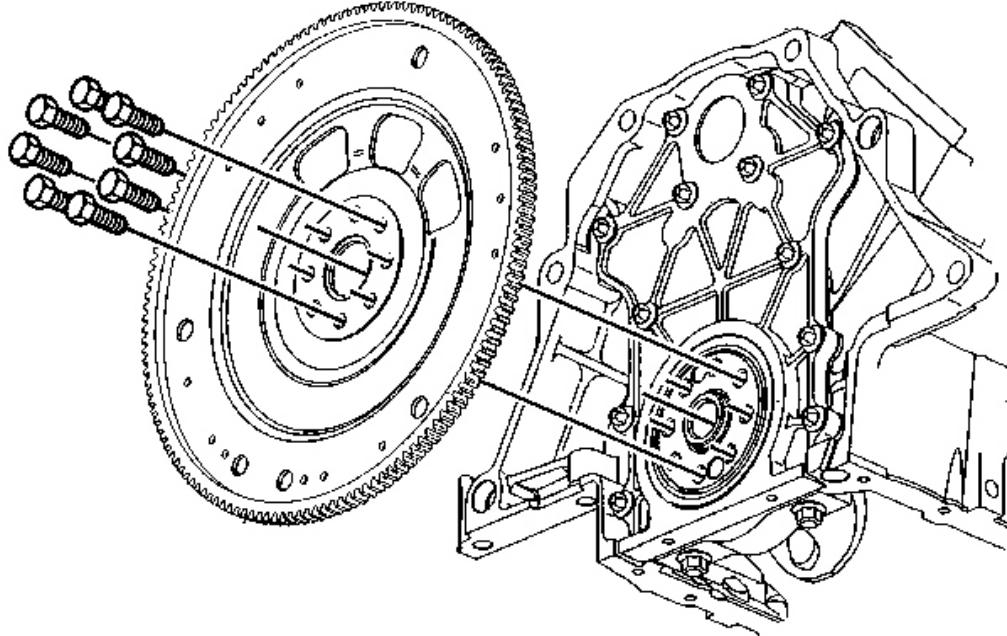


**Fig. 274: View Of Engine Flywheel & Bolts**

**Courtesy of GENERAL MOTORS CORP.**

79. Loosen the flywheel bolts.
80. Remove 7 of the 8 flywheel bolts, leaving 1 bolt at the top of the crankshaft rotation.
81. Firmly grasp the flywheel and remove the remaining bolt. Do not drop the flywheel when removing the final bolt.
82. Remove the flywheel.
83. Install the engine to a engine stand.
84. Transfer any components as required. Refer to the appropriate procedures.

#### **Installation Procedure**



**Fig. 275: View Of Engine Flywheel & Bolts**

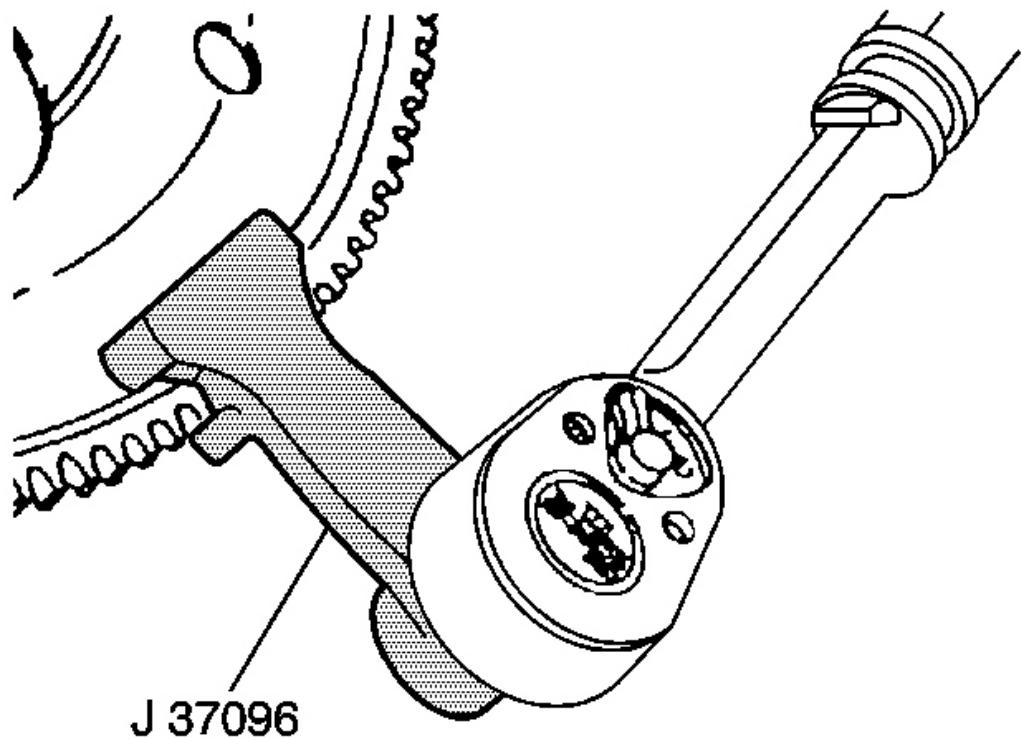
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine from the engine stand.
2. Install the flywheel.
3. Install NEW flywheel bolts until snug.
4. Install the **J 37096** and ratchet to the flywheel to hold the flywheel. See **Special Tools**.

**NOTE: Refer to Fastener Notice .**

5. Tighten the flywheel bolts.

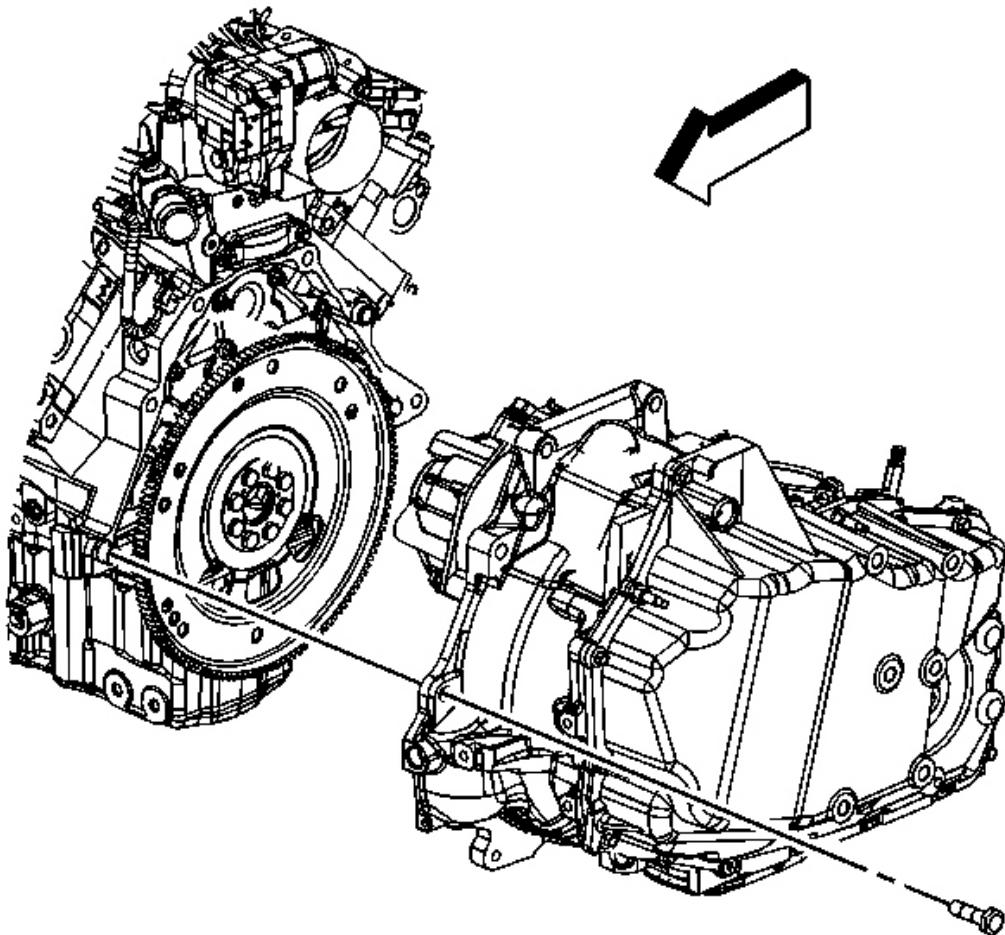
**Tighten:** Tighten the bolts to 15 N.m (11 lb ft) plus an additional 50 degrees using **J 45059** . See **Special Tools**.



**Fig. 276: Holding Flywheel**

Courtesy of GENERAL MOTORS CORP.

6. Install the **J 37096** to a ratchet. See **Special Tools**.
7. Install the **J 37096** and ratchet to the flywheel to hold the flywheel. See **Special Tools**.

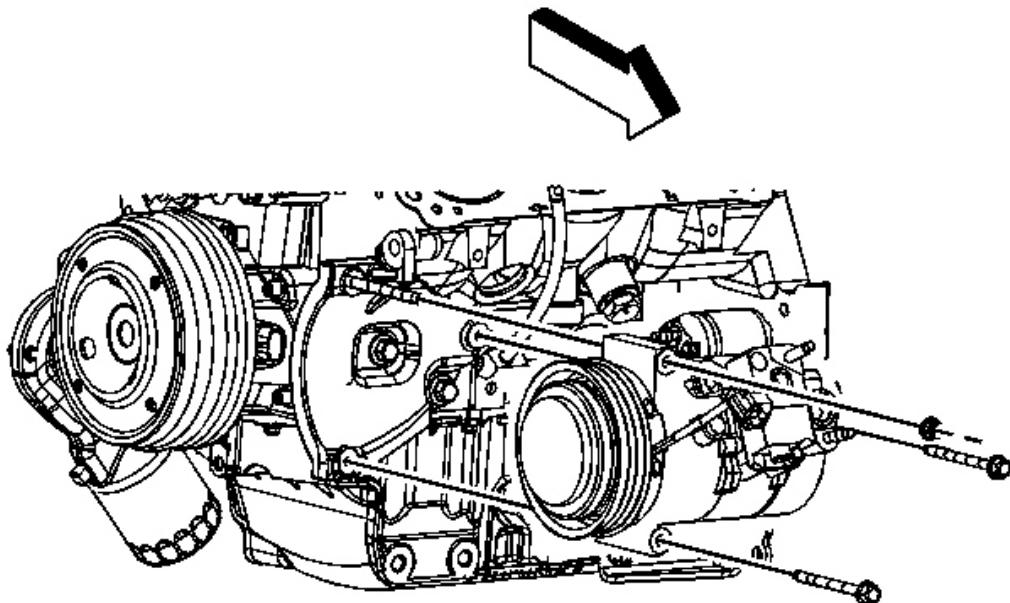


**Fig. 277: Identifying Upper Transaxle Bolts**  
Courtesy of GENERAL MOTORS CORP.

8. With the aid of an assistant, install the engine to the vehicle.
9. Install the upper transaxle bolts.

**Tighten:** Tighten the bolts to 75 N.m (55 lb ft).

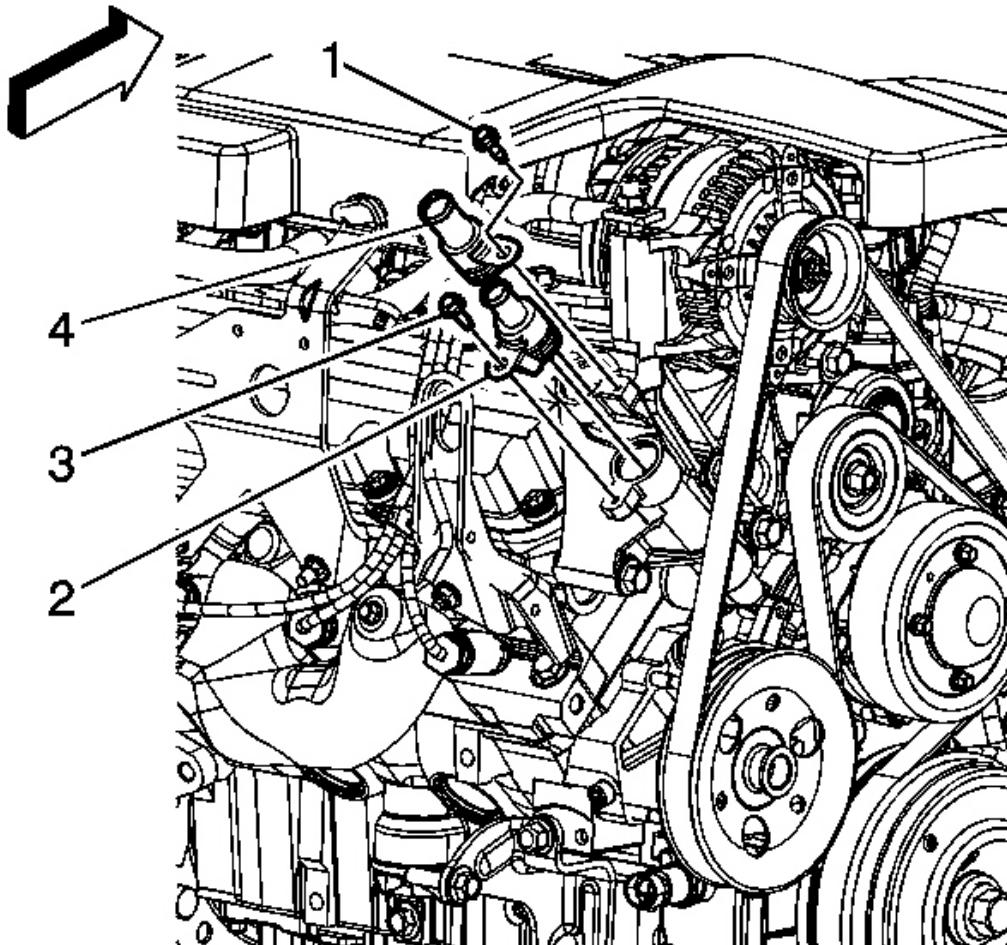
10. Remove the engine lifting device from the lift brackets.



**Fig. 278: Identifying A/C Compressor & Mounting Bolts**  
Courtesy of GENERAL MOTORS CORP.

11. Unsecure and position the A/C compressor to the engine.
12. Install the A/C compressor bolts and nut.

**Tighten:** Tighten the bolts/nut to 25 N.m (18 lb ft).

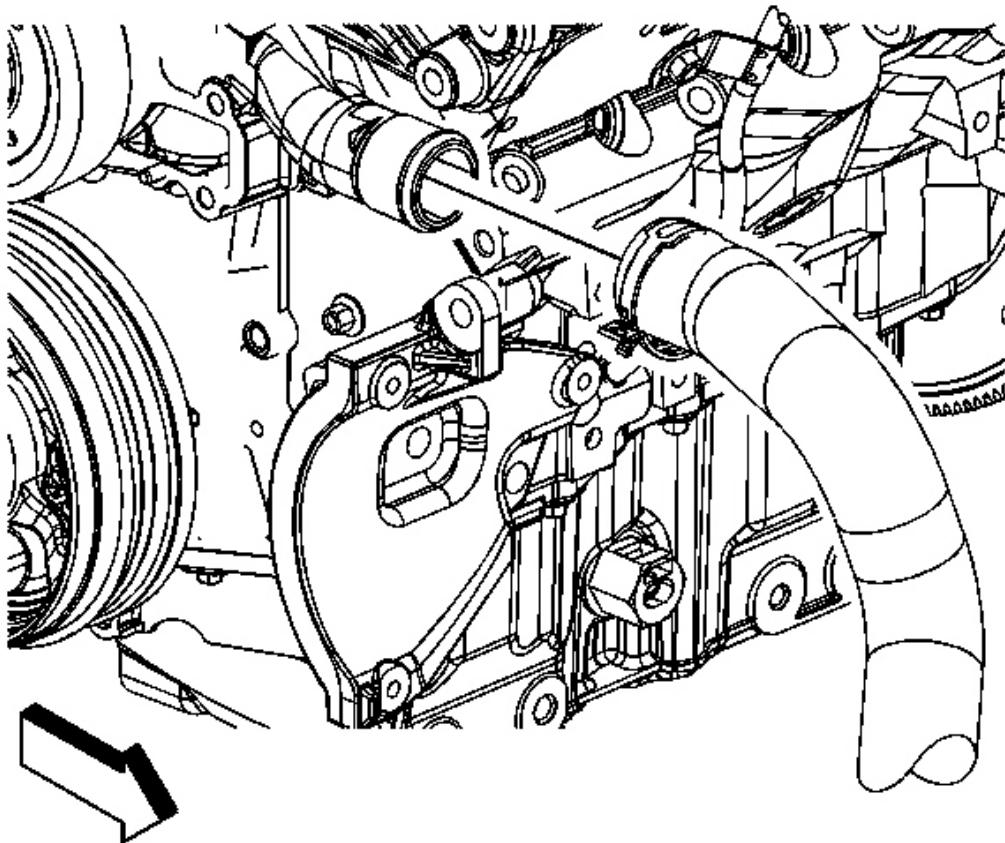


**Fig. 279: Identifying Hose Adapter Bolts**

Courtesy of GENERAL MOTORS CORP.

13. Install the heater inlet (4) and outlet (2) adapters to the drive belt tensioner. (heater hoses shown removed for clarity).
14. Install the heater inlet and outlet hose adapter bolts (1, 3).

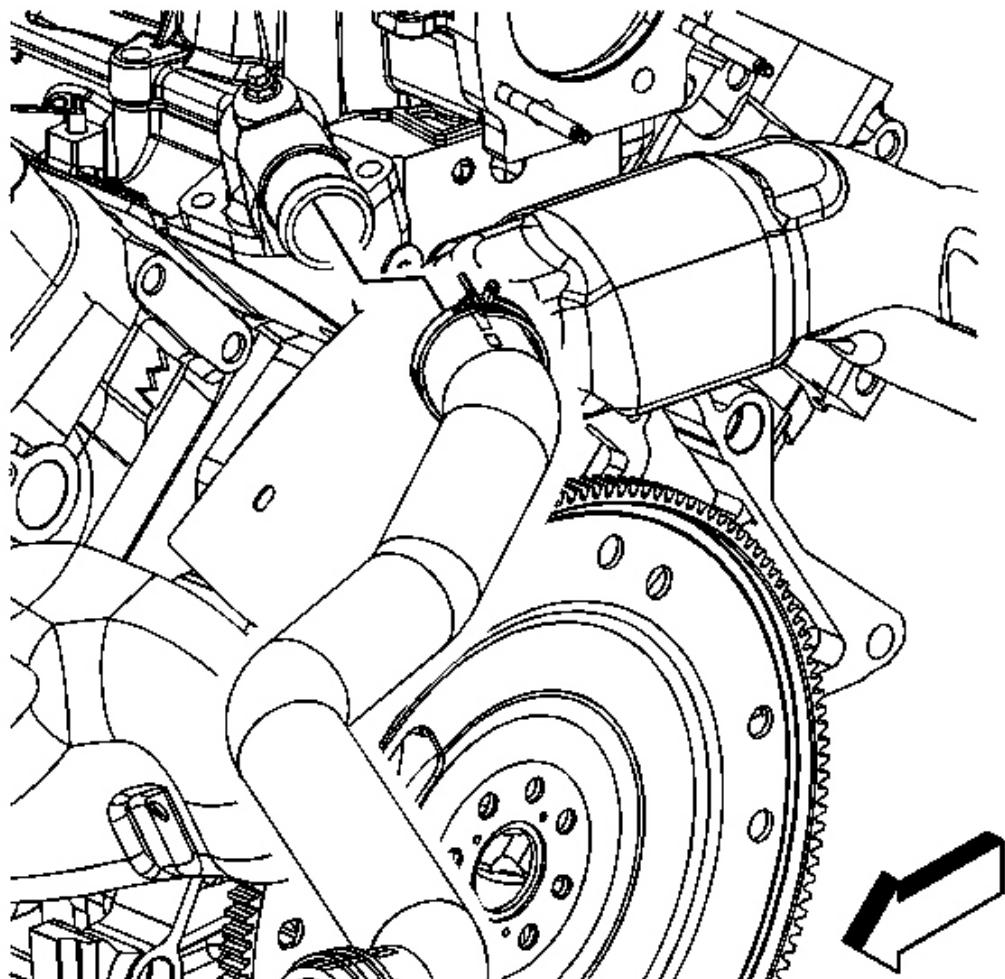
**Tighten:** Tighten the bolts to 10 N.m (89 lb in).



**Fig. 280: Identifying Radiator Outlet Hose**

Courtesy of GENERAL MOTORS CORP.

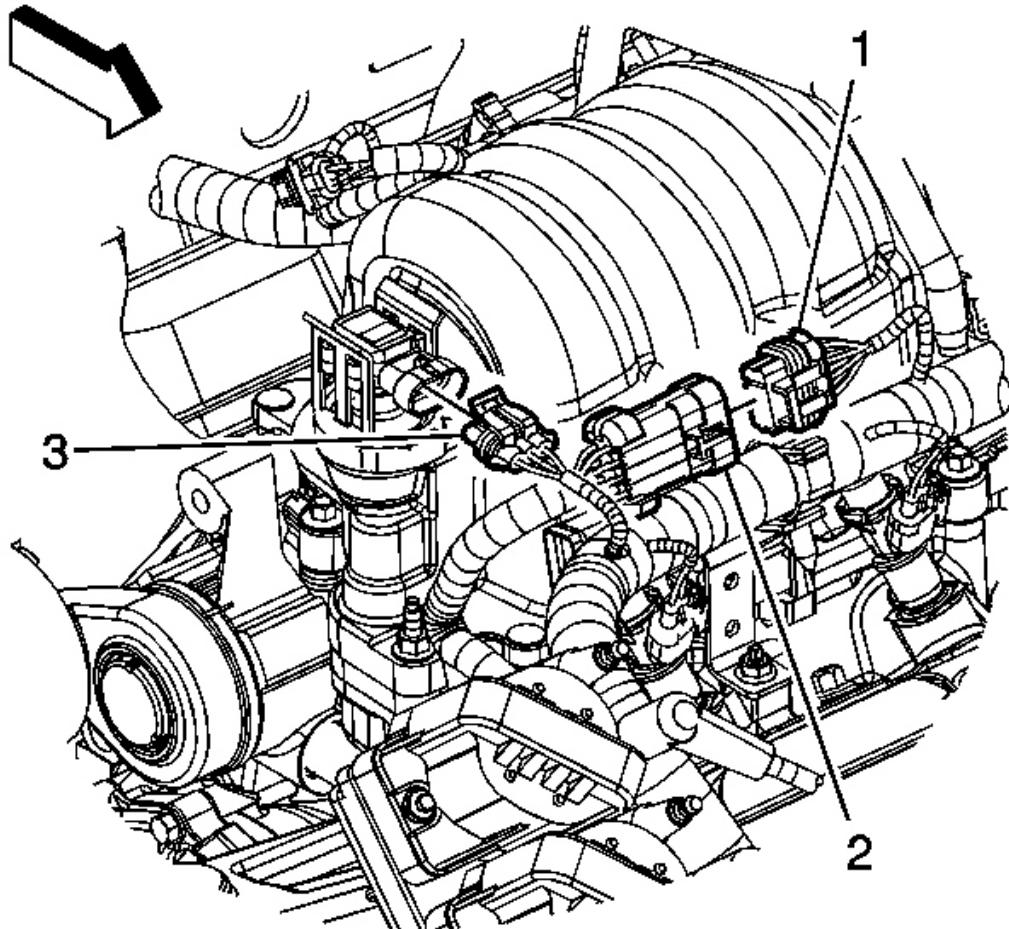
15. Install the radiator outlet hose to the front cover.
16. Using **J 38185** position the radiator outlet hose clamp at the front cover. See **Special Tools**.



**Fig. 281: Locating Inlet Hose Clamps**

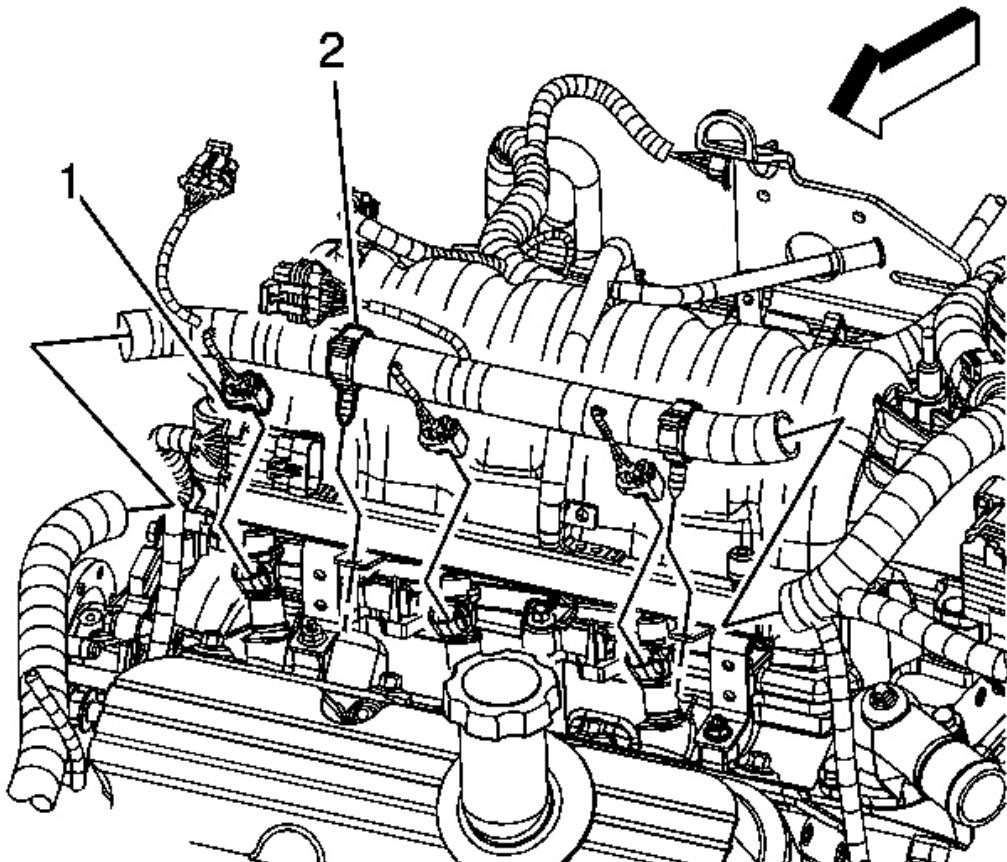
Courtesy of GENERAL MOTORS CORP.

17. Install the radiator inlet hose to the thermostat housing.
18. Using **J 38185** position the radiator inlet hose clamp at the thermostat housing. See **Special Tools**.



**Fig. 282: Identifying Engine Control Module Harness Connectors**  
Courtesy of GENERAL MOTORS CORP.

19. Position the engine wiring harness over the engine.
20. Connect the engine harness electrical connector (3) to the MAP sensor.
21. Connect the engine harness electrical connector (1) to the ignition control module harness electrical connector (2).



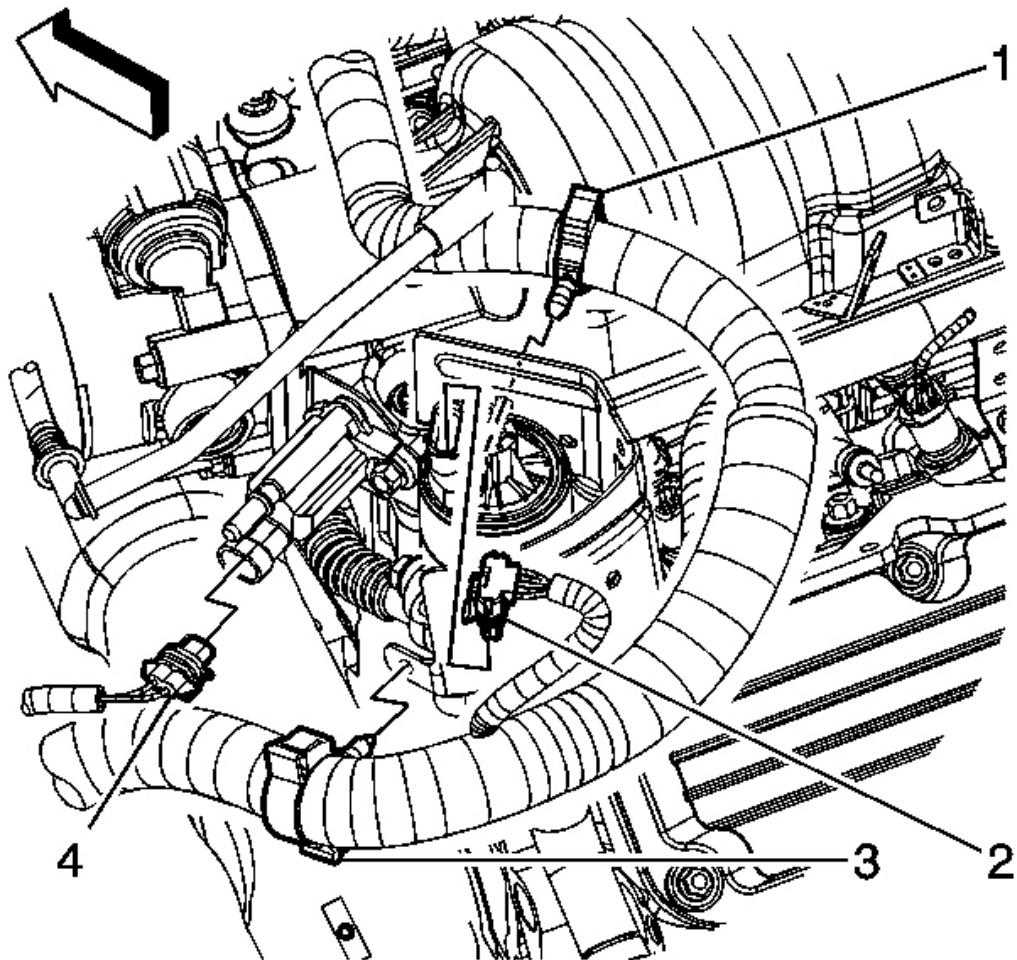
**Fig. 283: Identifying Engine Harness Connectors**

Courtesy of GENERAL MOTORS CORP.

22. Install the engine harness retainers (2) to the fuel rail.
23. Connect the engine harness electrical connectors (1) to the front fuel injectors.
24. Connect the engine harness electrical connector (2) to the EGR valve.

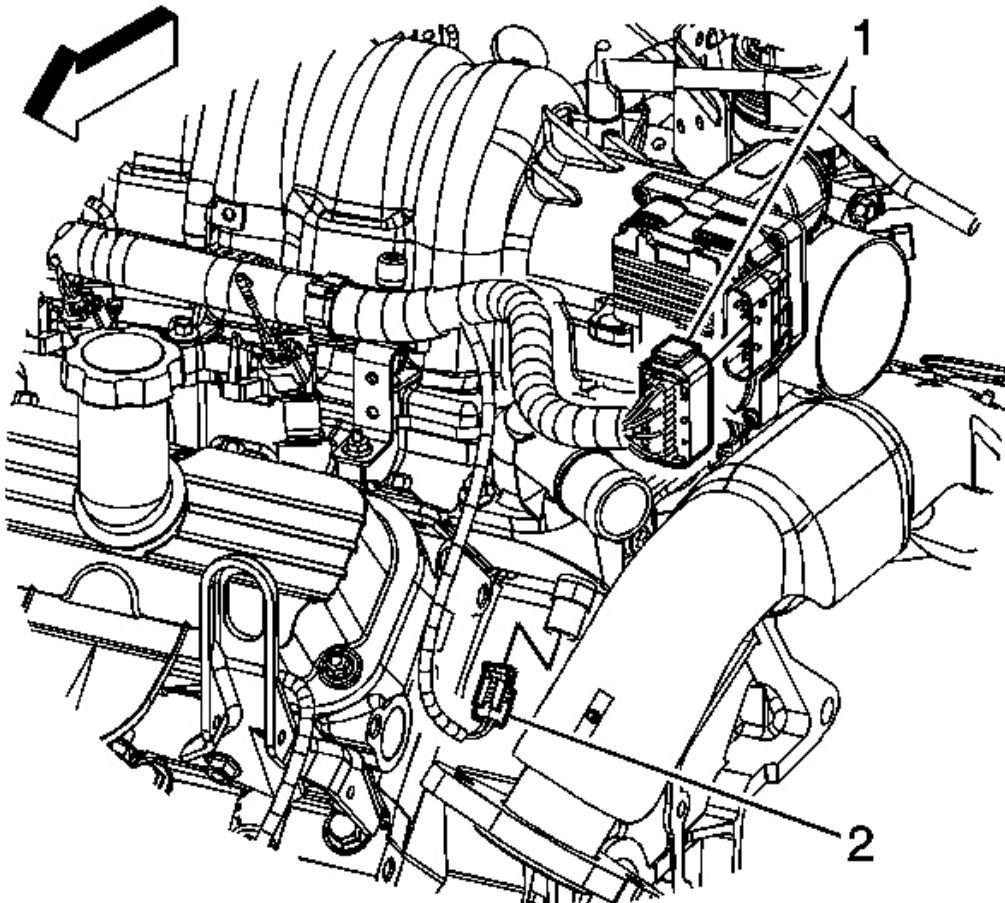
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**Fig. 284: Identifying Engine Harness Clips**  
Courtesy of GENERAL MOTORS CORP.

25. Connect the engine harness clips (1, 3) to the heat shield.

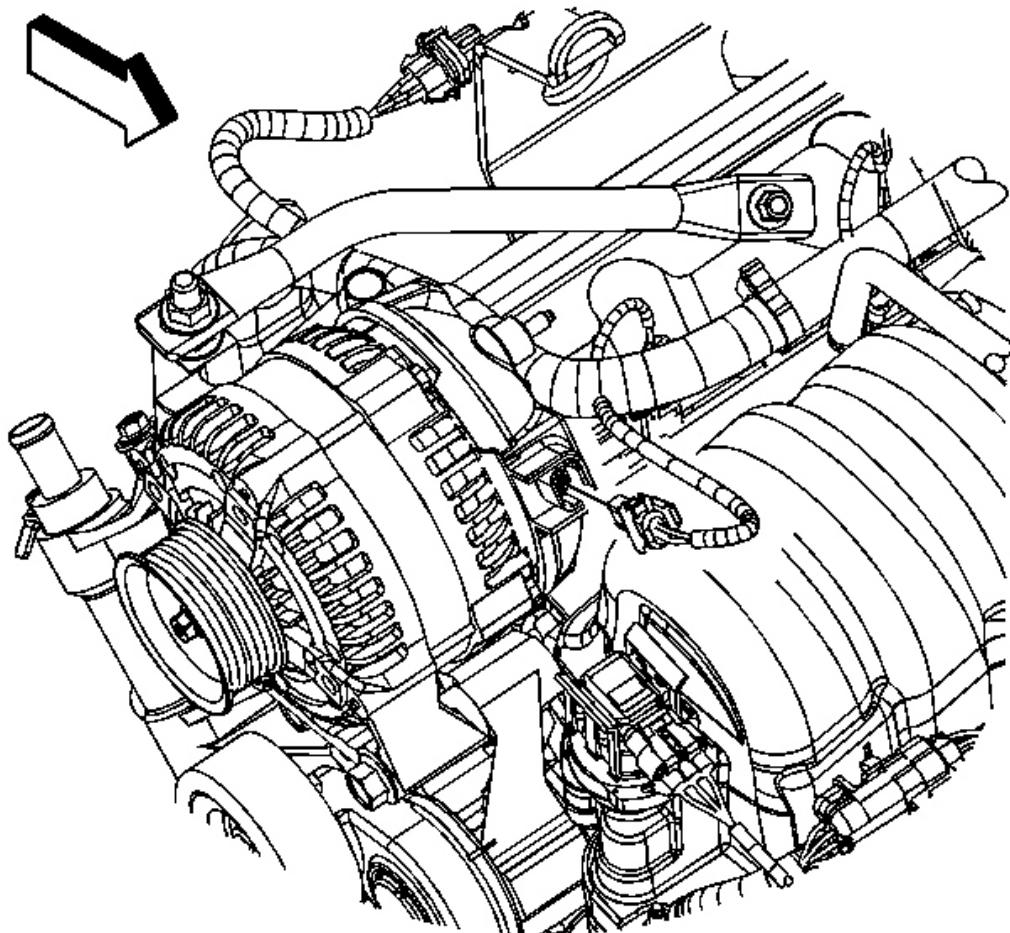


**Fig. 285: Identifying Throttle Actuator Harness Connector**  
Courtesy of GENERAL MOTORS CORP.

26. Connect the engine harness electrical connector (2) to the ECT sensor.
27. Connect the engine harness electrical connector (1) to the throttle actuator.

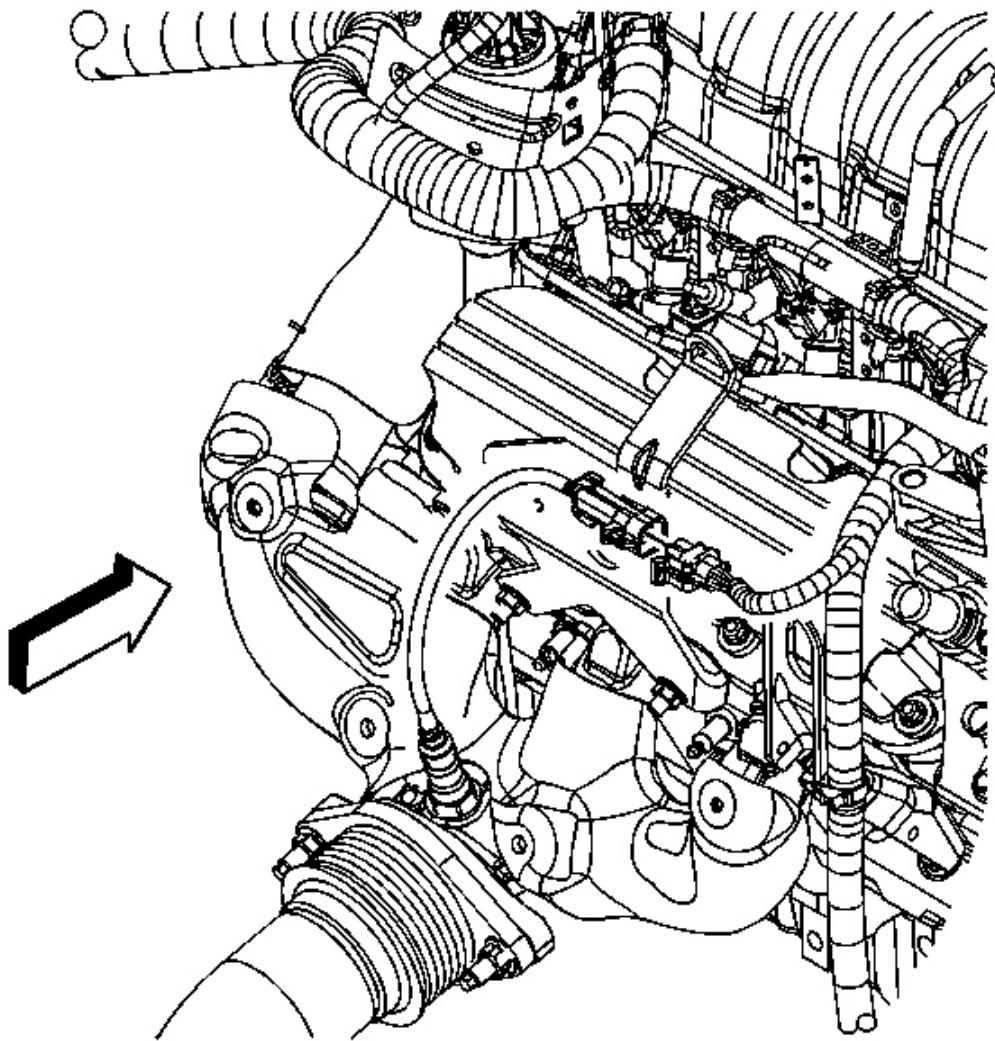
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**Fig. 286: Identifying Generator Harness Electrical Connector**  
Courtesy of GENERAL MOTORS CORP.

28. Connect the engine harness electrical connector to the generator.



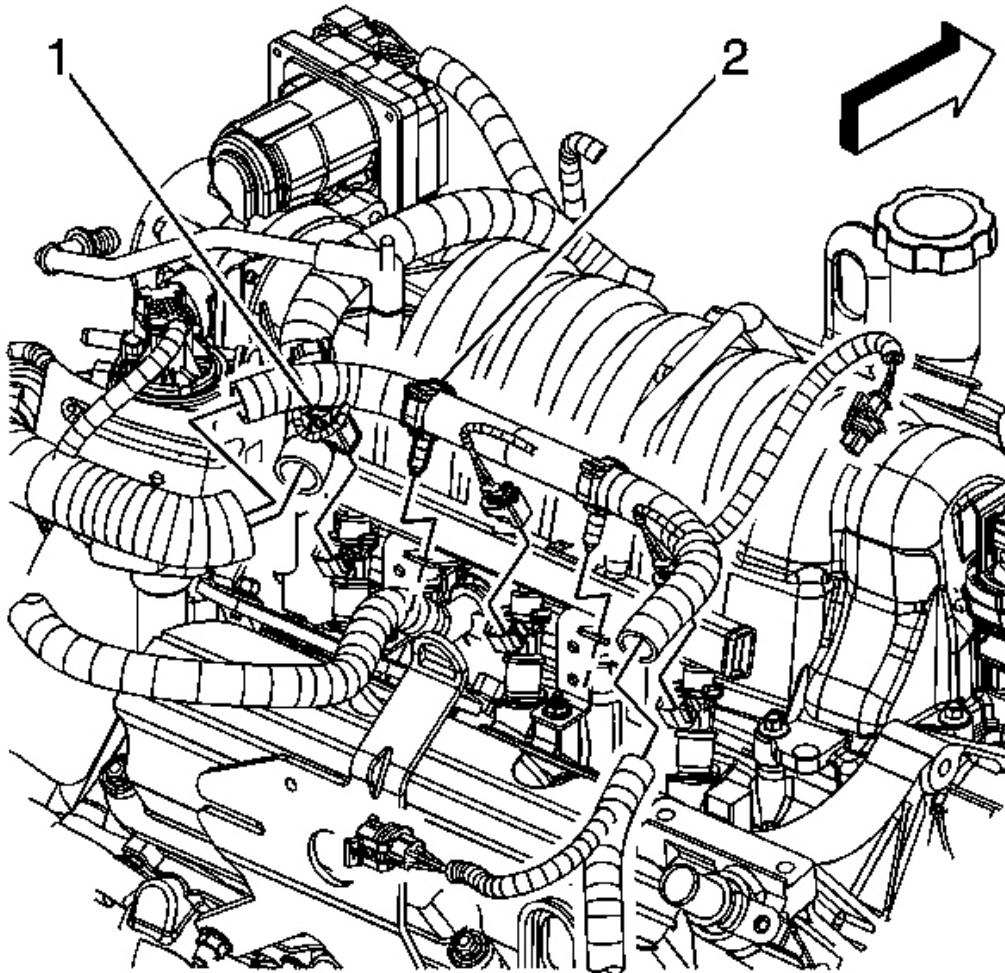
**Fig. 287: View Of Right Side Exhaust Manifold & Rear Heated Oxygen Sensor (HO2S)**

Courtesy of GENERAL MOTORS CORP.

29. Connect the engine harness electrical connector to the rear HO2S.

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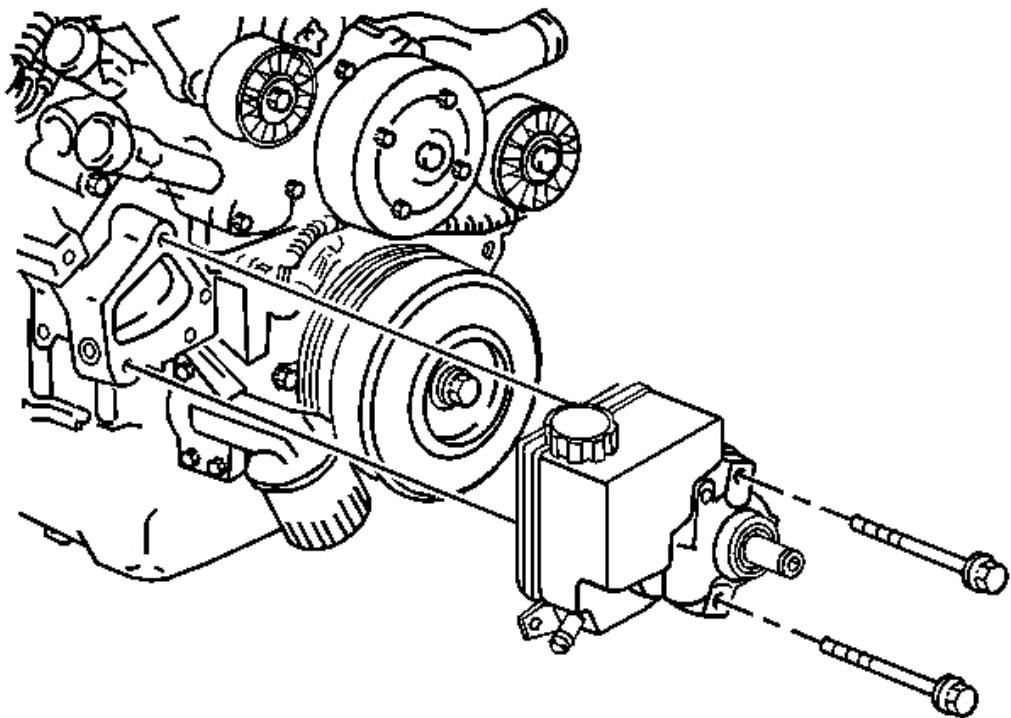
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**Fig. 288: Locating Engine Harness Electrical Connectors**

Courtesy of GENERAL MOTORS CORP.

30. Install the engine harness electrical connector retainers (2) to the fuel rail.
31. Connect the engine harness electrical connectors (1) to the rear fuel injectors.



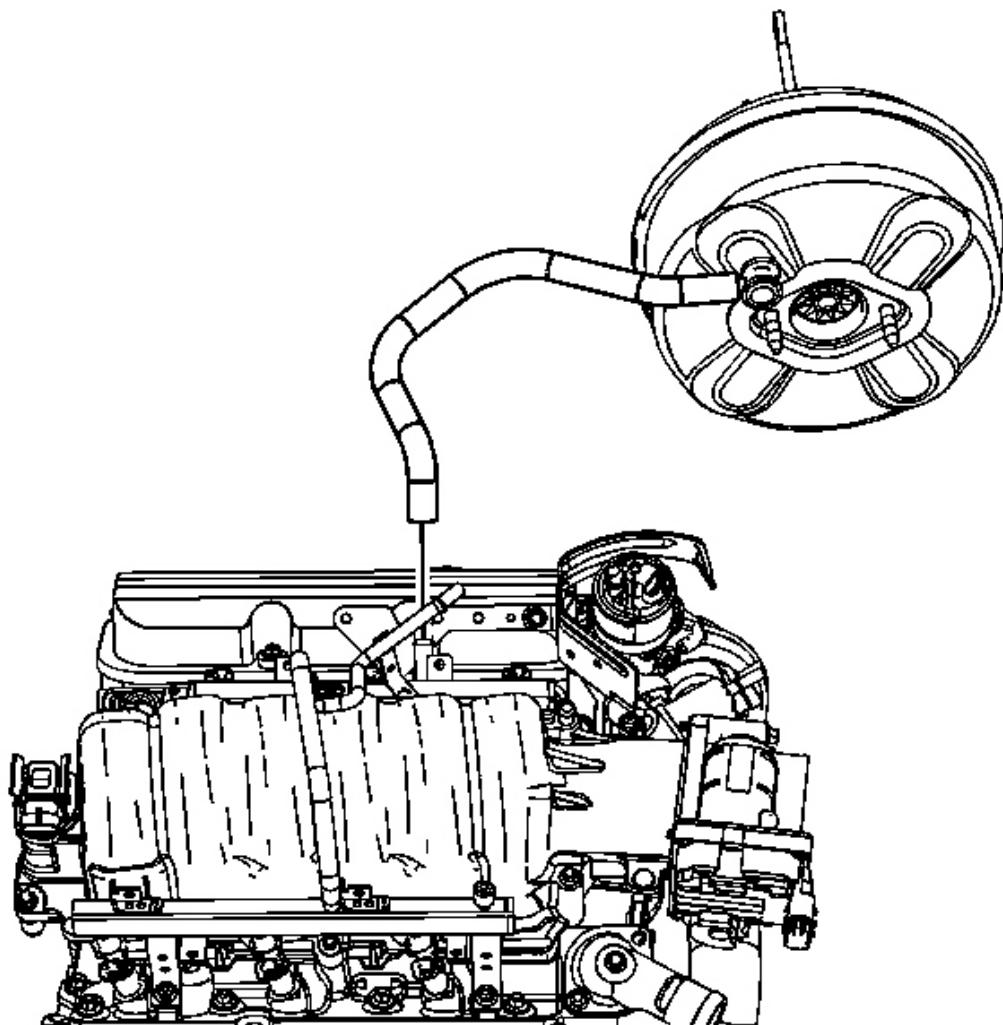
**Fig. 289: View Of Power Steering Pump And Mounting Bolts**  
Courtesy of GENERAL MOTORS CORP.

32. Position the power steering pump and install the power steering pump bolts. (pulley shown removed for clarity).

**Tighten:** Tighten the bolts to 34 N.m (25 lb ft).

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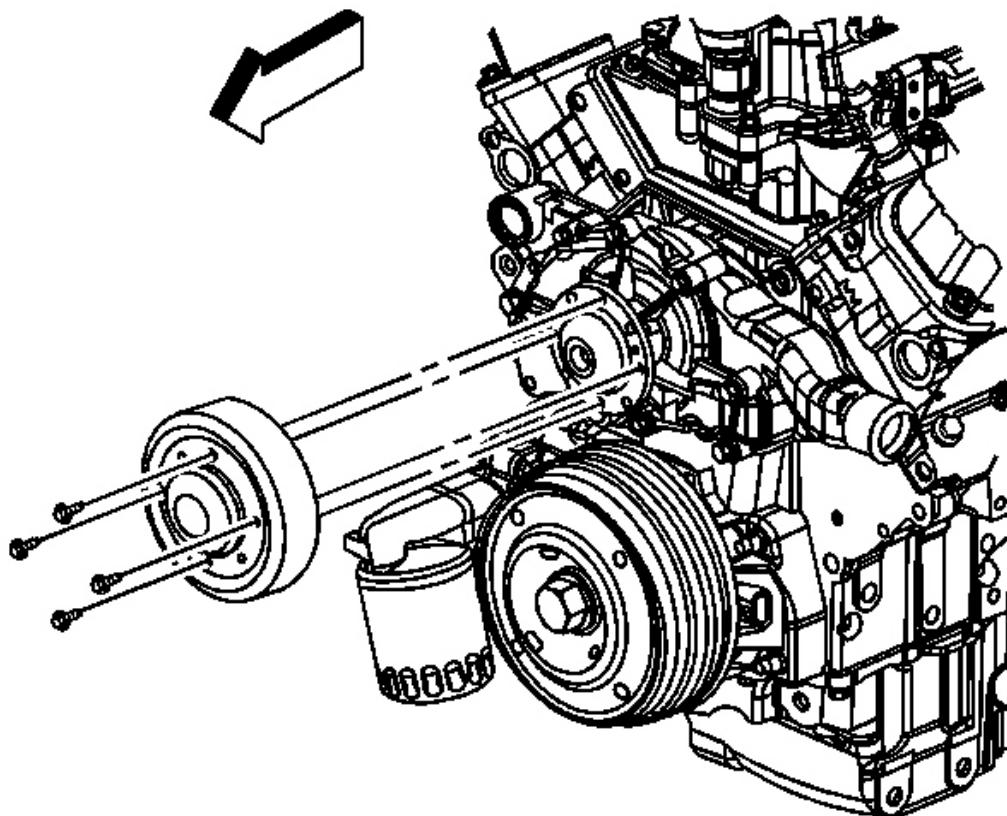
2006 ENGINE Engine Mechanical - 3.8L - Lucerne



**Fig. 290: View Of Brake Booster Vacuum Hose**

Courtesy of GENERAL MOTORS CORP.

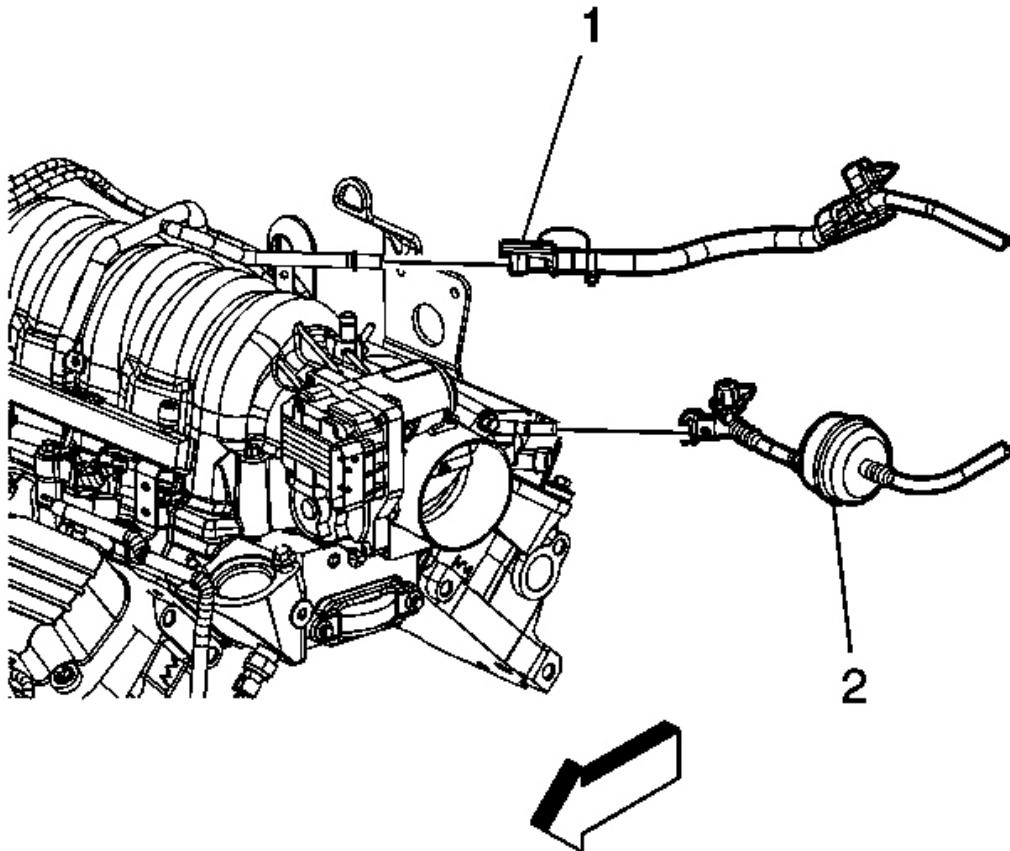
33. Install the brake booster vacuum hose to the intake manifold.
34. Install the fan shroud. Refer to [Fan Shroud Replacement \(L26\)](#) or [Fan Shroud Replacement \(LD8\)](#) .
35. Install the engine mount strut. Refer to [Engine Mount Strut Replacement](#).



**Fig. 291: Identifying Water Pump Pulley & Bolts**  
Courtesy of GENERAL MOTORS CORP.

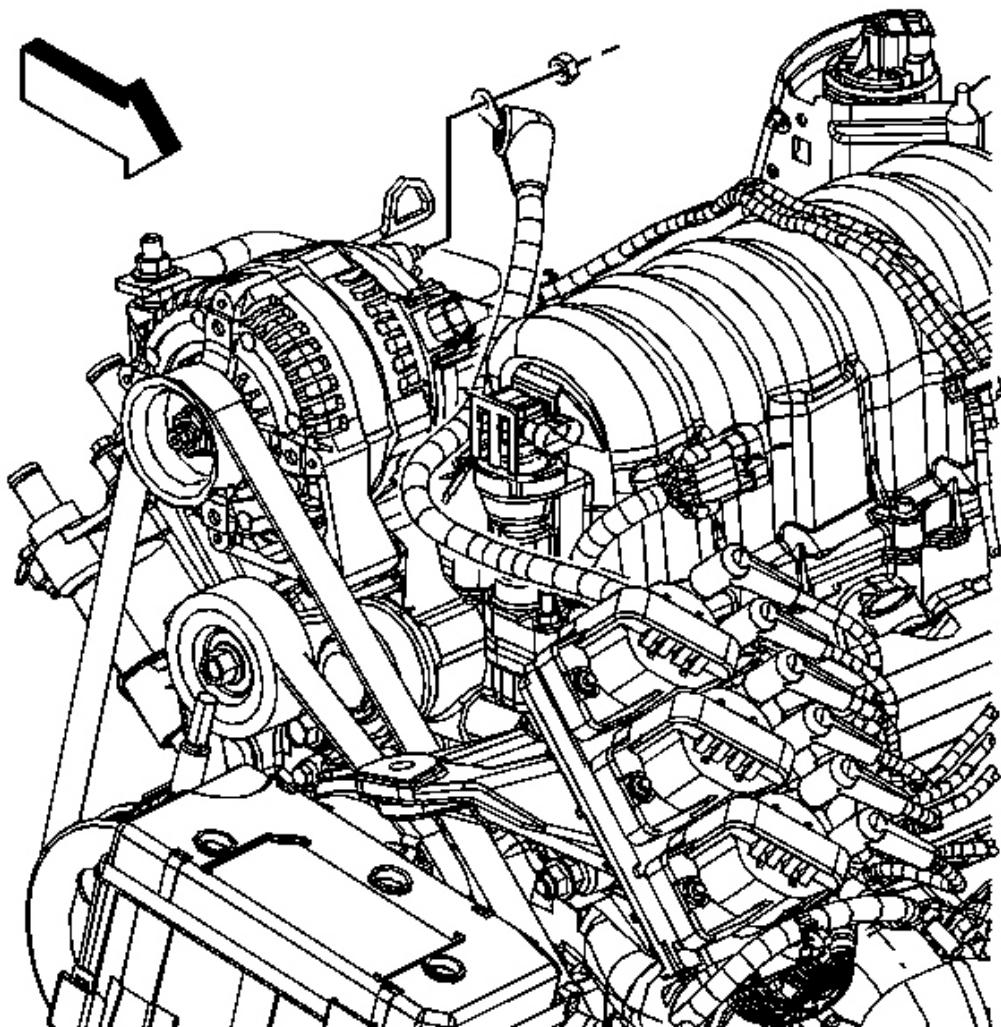
36. Install the water pump pulley and bolts until snug.
37. Install the drive belt. Refer to [Drive Belt Replacement](#).
38. Tighten the water pump pulley bolts.

**Tighten:** Tighten the bolts to 13 N.m (115 lb in).



**Fig. 292: Locating Evaporative Emission (EVAP) Pipe Quick Connect Fitting**  
Courtesy of GENERAL MOTORS CORP.

39. Connect the EVAP line (2) quick connect fitting to the purge solenoid. Refer to [Plastic Collar Quick Connect Fitting Service](#) .
40. Connect the fuel feed line (1) quick connect fitting to the fuel rail. Refer to [Metal Collar Quick Connect Fitting Service](#) .



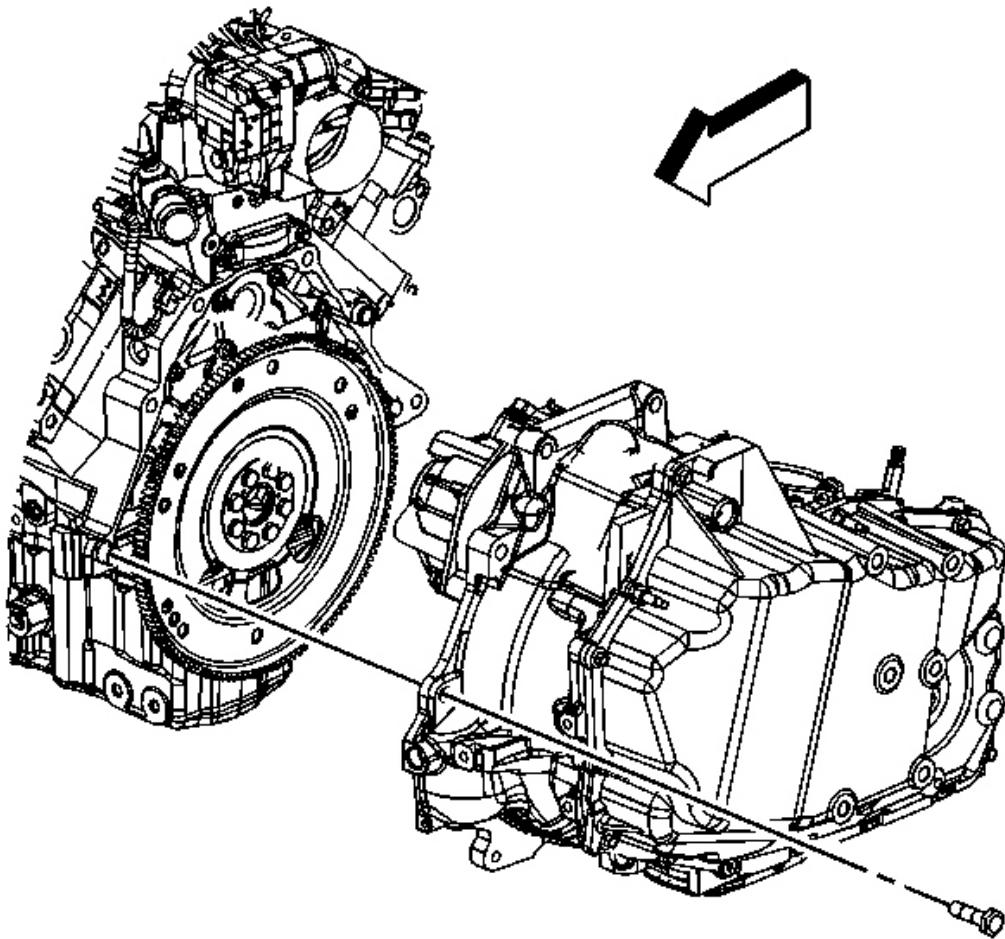
**Fig. 293: Identifying Generator Terminal Nut**  
Courtesy of GENERAL MOTORS CORP.

41. Install the starter cable to the generator.
42. Install the generator terminal nut.

**Tighten:** Tighten the nut to 20 N.m (15 lb ft).

43. Position the starter cable boot.

44. Install the air cleaner assembly. Refer to [Air Cleaner Assembly Replacement](#) .



**Fig. 294: Identifying Lower Front Transaxle Bolt**

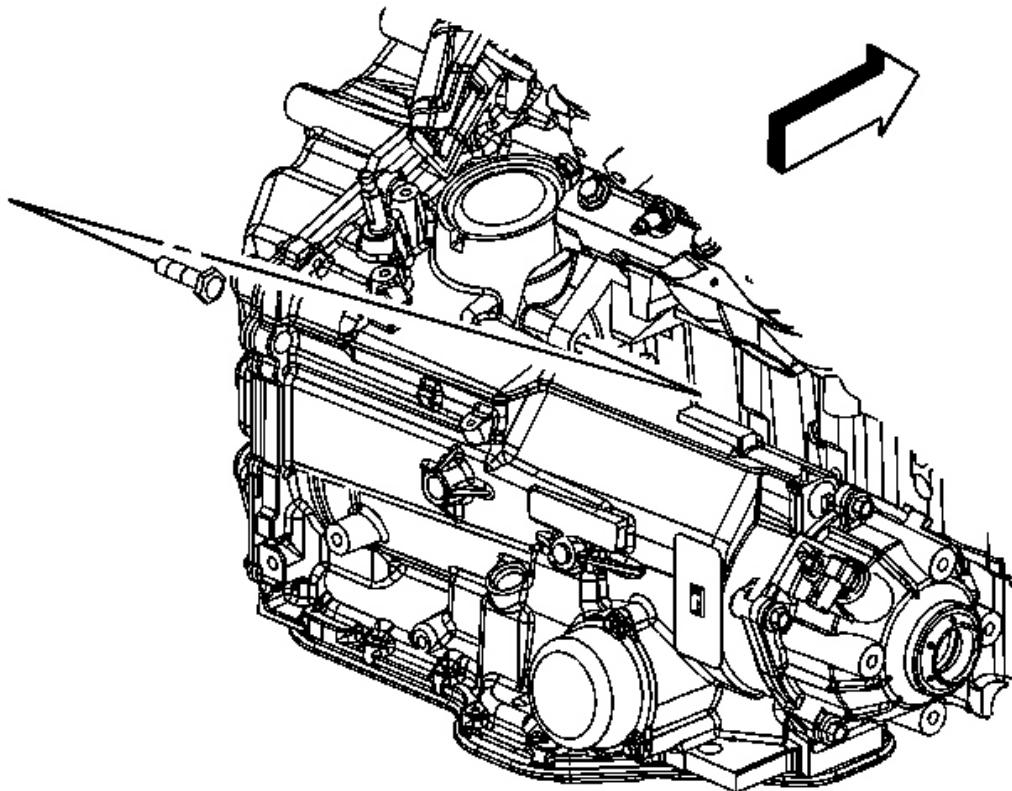
Courtesy of GENERAL MOTORS CORP.

45. Raise the vehicle.  
46. Install the lower front transaxle bolt.

**Tighten:** Tighten the bolt to 75 N.m (55 lb ft).

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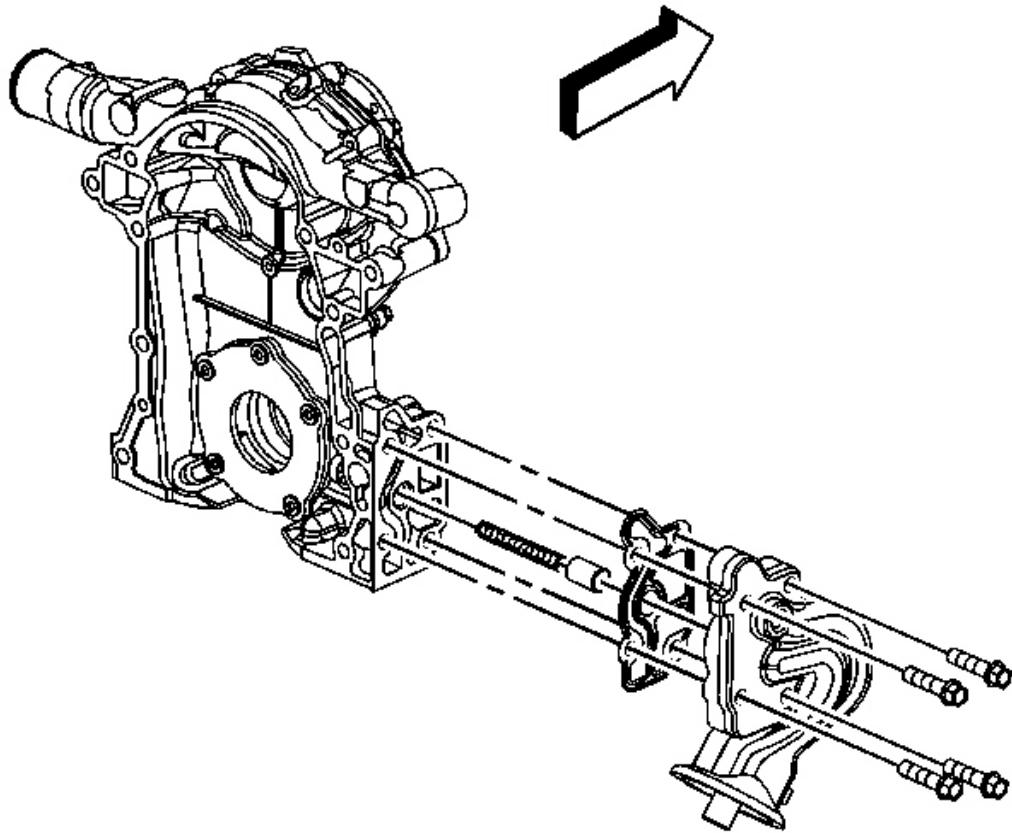
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**Fig. 295: View Of Transaxle**  
Courtesy of GENERAL MOTORS CORP.

47. Install the lower rear transaxle bolt.

**Tighten:** Tighten the bolt to 75 N.m (55 lb ft).



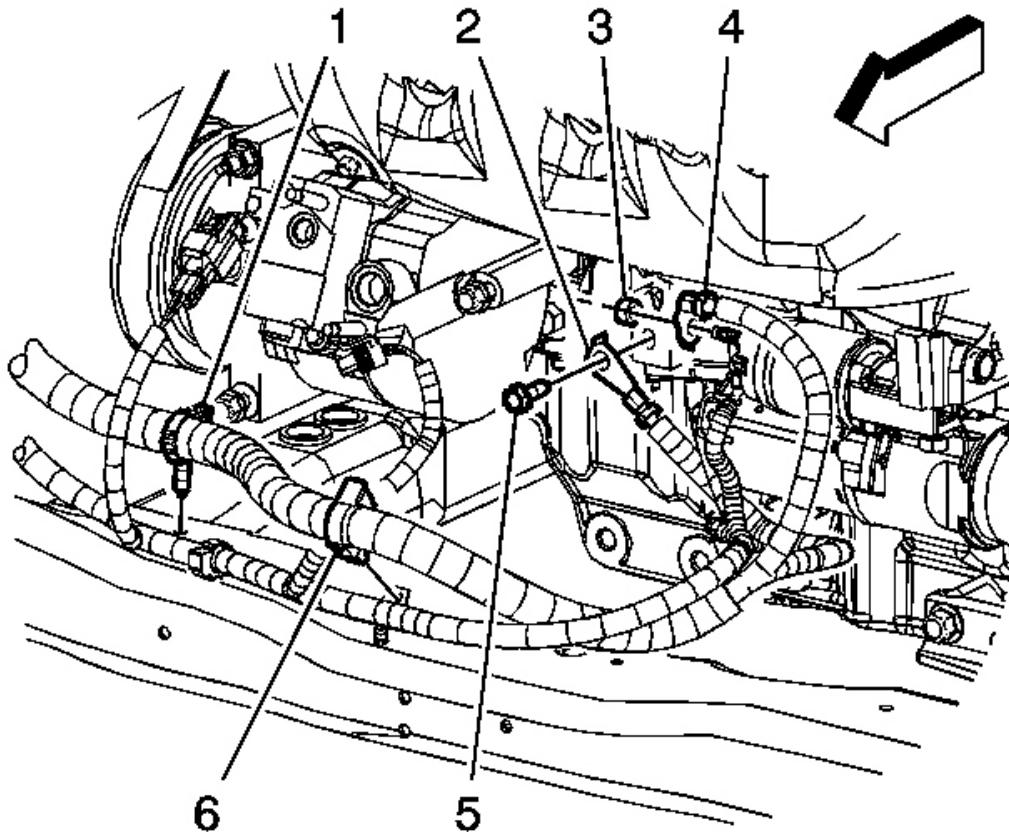
**Fig. 296: Identifying Oil Filter Adapter & Bolts**

Courtesy of GENERAL MOTORS CORP.

48. Position the oil filter adapter gasket and adapter.
49. Install the oil filter adapter bolts.

**Tighten:** Tighten the bolts to 50 N.m (37 lb ft) plus an additional 3 degrees using **J 45059** .  
See Special Tools.

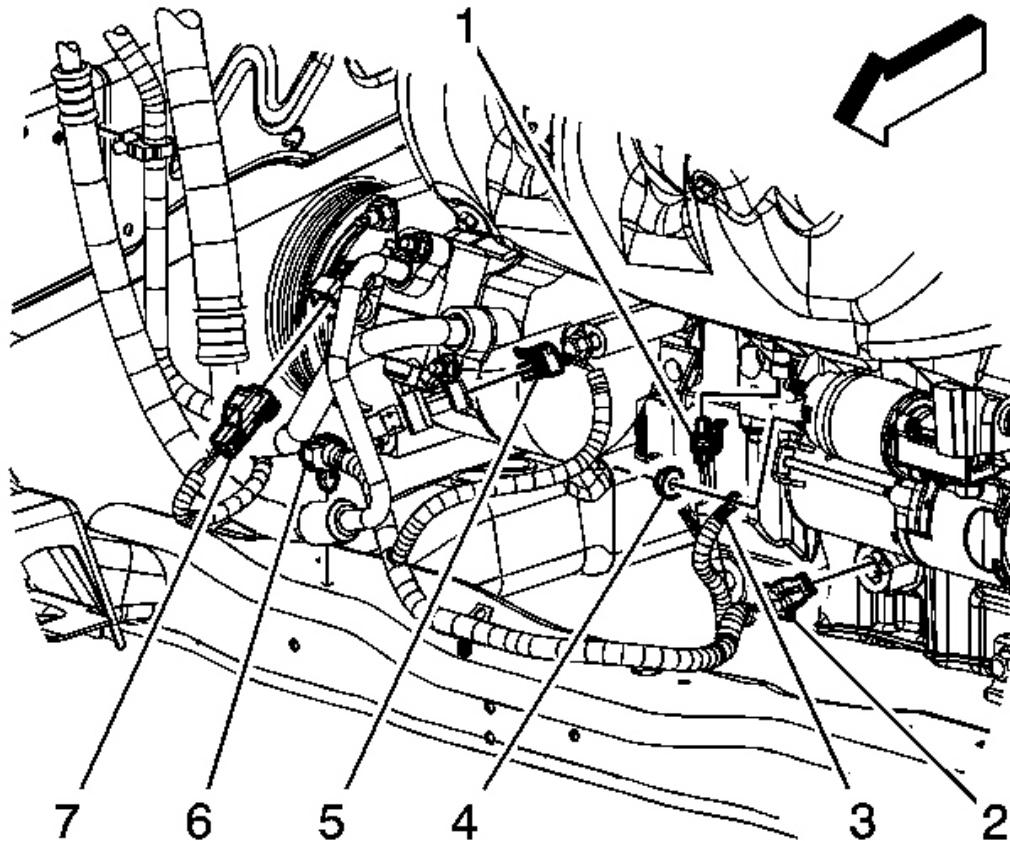
50. Install the right wheel drive shaft. Refer to Wheel Drive Shaft Replacement .



**Fig. 297: Identifying Starter Solenoid & Starter Motor Cable Terminals**  
Courtesy of GENERAL MOTORS CORP.

51. Position the starter cable terminal (2) to the engine and install the starter cable ground bolt (5).

**Tighten:** Tighten the bolt to 25 N.m (18 lb ft).

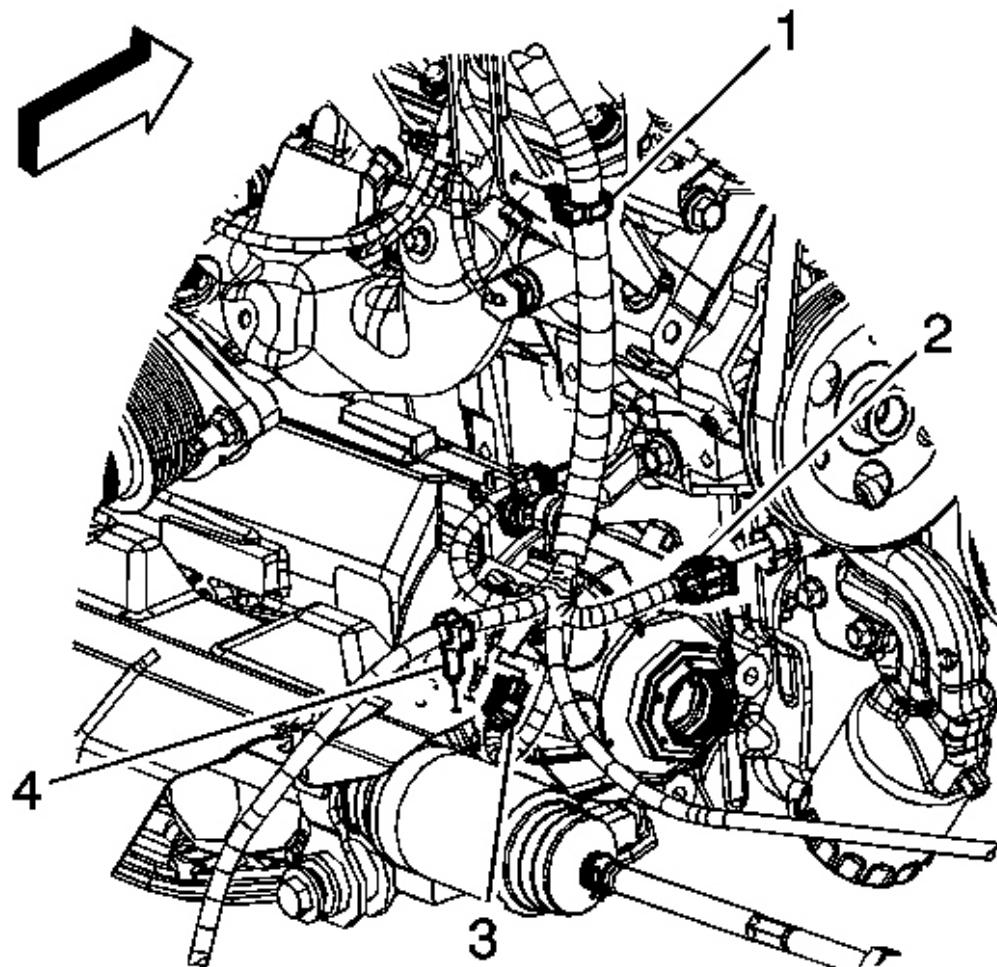


**Fig. 298: View Of Engine Harness Electrical Connectors**

Courtesy of GENERAL MOTORS CORP.

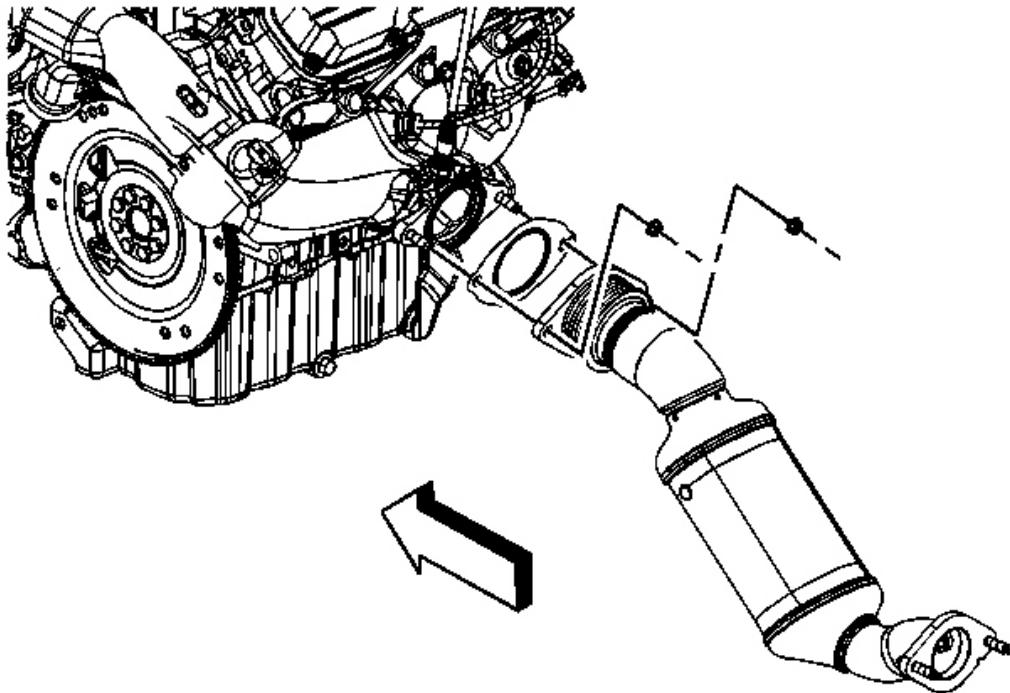
52. Connect the engine harness electrical connector (7) to the A/C compressor.
53. Connect the engine harness electrical connector (5) to the A/C pressure sensor.
54. Install the engine harness (3) terminal to the starter.
55. Install the starter solenoid "S" terminal nut (4).

**Tighten:** Tighten the nut to 2.3 N.m (20.5 lb in).



**Fig. 299: View Of Left Side Engine Compartment Components**  
Courtesy of GENERAL MOTORS CORP.

56. Connect the engine harness electrical connector to the rear knock sensor jumper harness.
57. Install the engine harness clip (4) to the steering gear bracket.
58. Install the engine harness clip (1) to the engine bracket.
59. Connect the engine harness electrical connector (3) to the VSS.
60. Connect the engine harness electrical connector (2) to the oil pressure sensor.



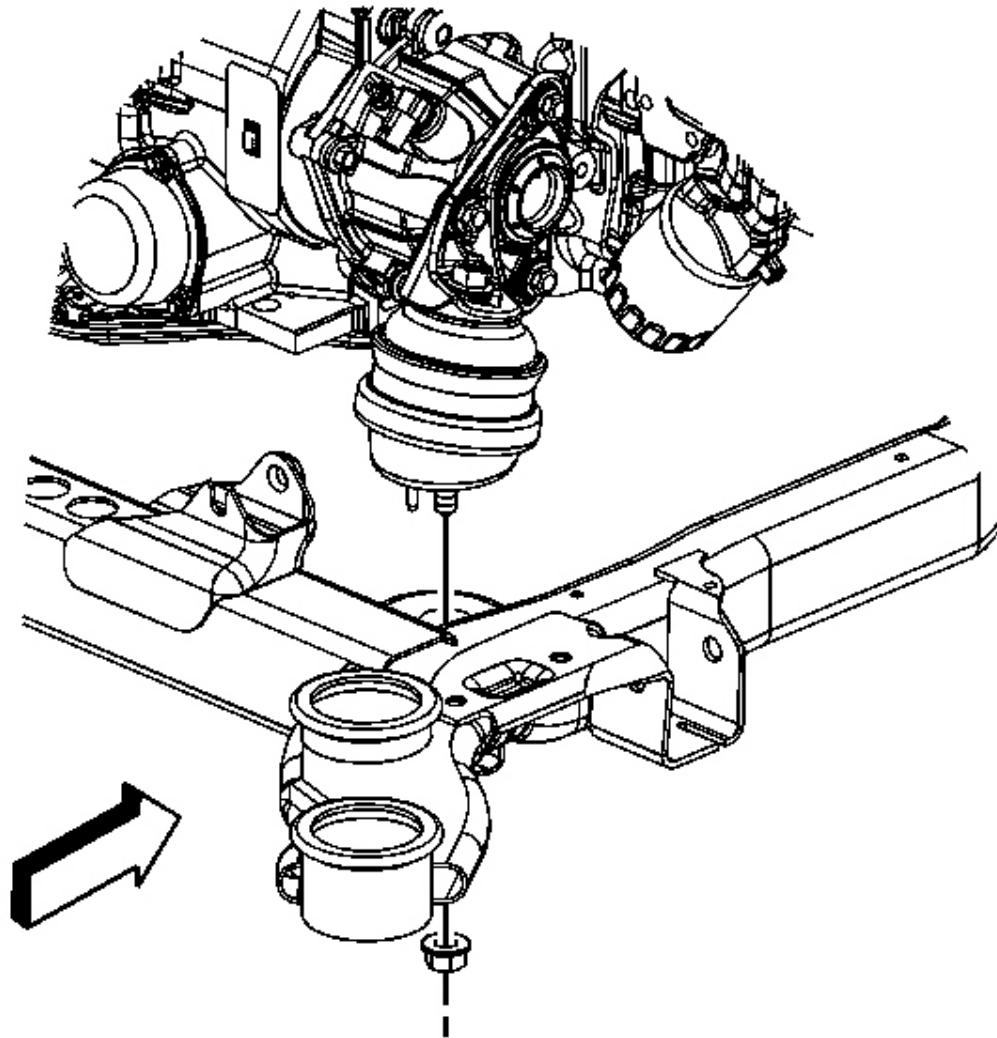
**Fig. 300: View Of Catalytic Converter-To-Exhaust Manifold Nuts**  
Courtesy of GENERAL MOTORS CORP.

61. Install the exhaust manifold to catalytic converter nuts.

**Tighten:** Tighten the nut to 30 N.m (22 lb ft).

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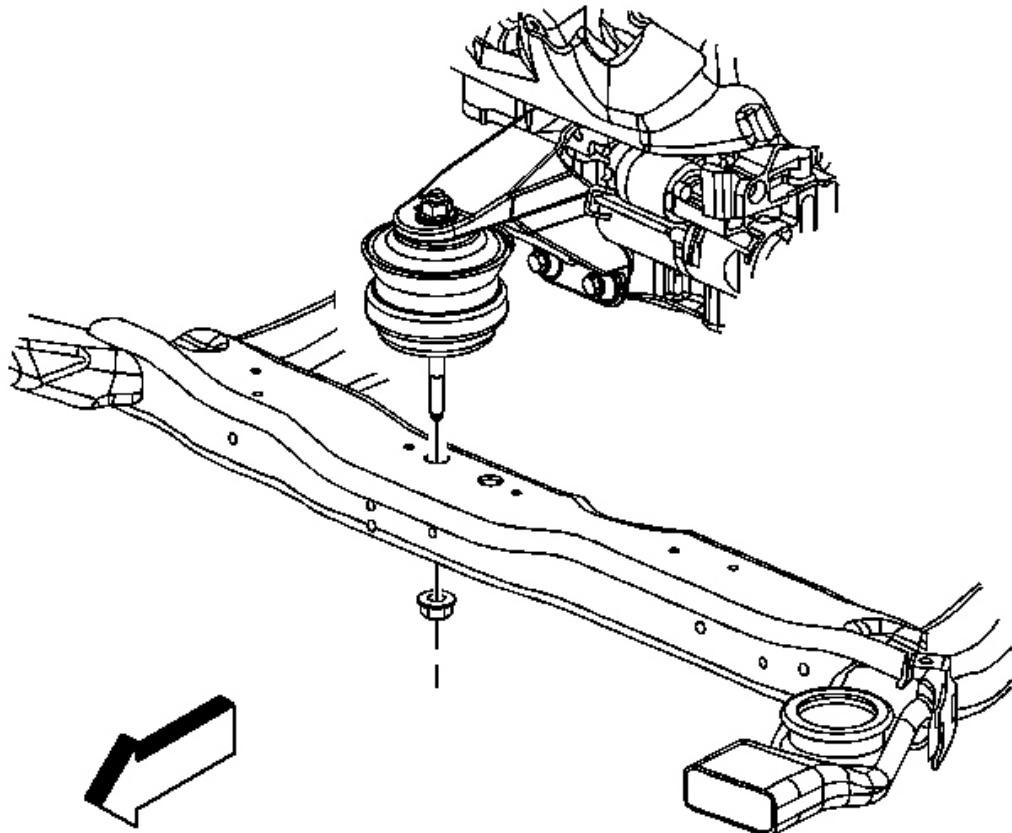
**Fig. 301: Identifying Engine Right Rear Mount To Frame Nut**  
Courtesy of GENERAL MOTORS CORP.

62. Install the rear engine mount to frame nut.

**Tighten:** Tighten the nut to 80 N.m (59 lb ft).

## 2006 Buick Lucerne CXS

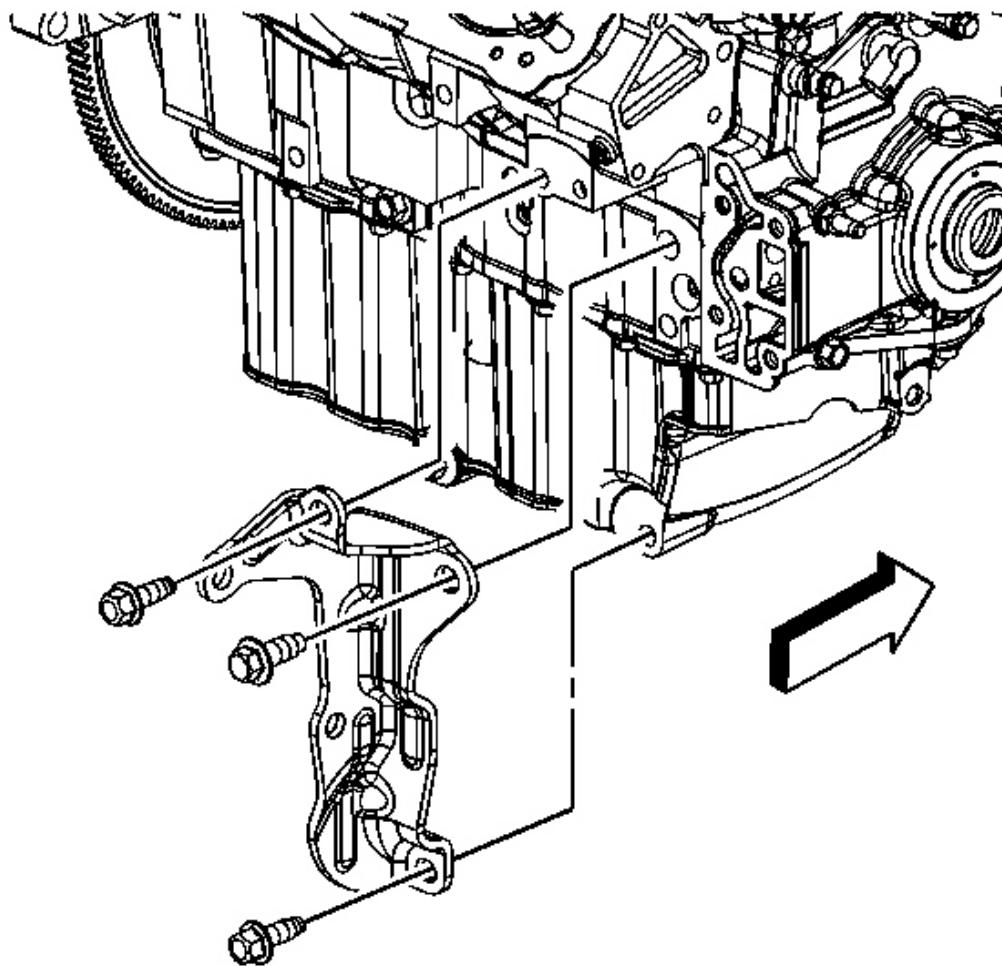
2006 ENGINE Engine Mechanical - 3.8L - Lucerne



**Fig. 302: Identifying Engine Front Mount-To-Frame Nut**  
Courtesy of GENERAL MOTORS CORP.

63. Install the front engine mount to frame nut.

**Tighten:** Tighten the nut to 80 N.m (59 lb ft).



**Fig. 303: Identifying Transaxle Brace-To-Oil Pan & Bolts**

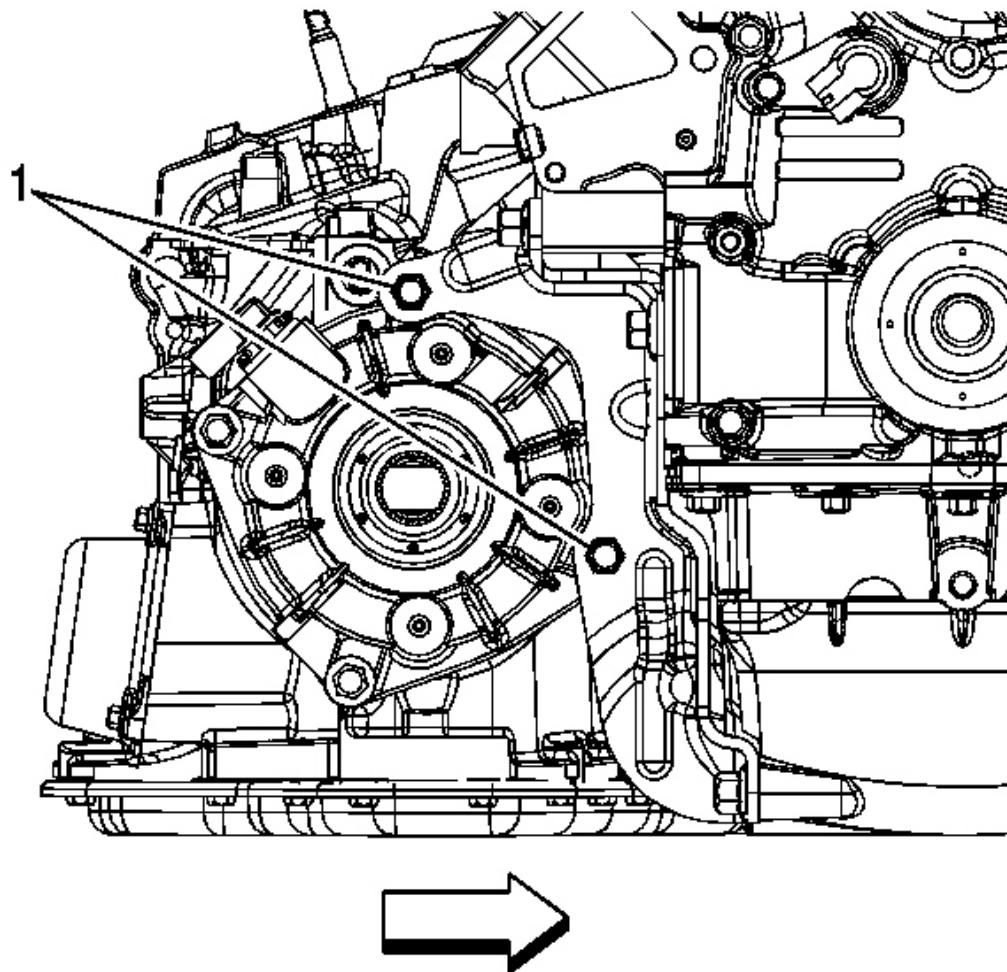
Courtesy of GENERAL MOTORS CORP.

64. Position the transaxle brace to the engine and install the bolts to the engine and oil pan.

**Tighten:** Tighten the bolts to 50 N.m (37 lb ft).

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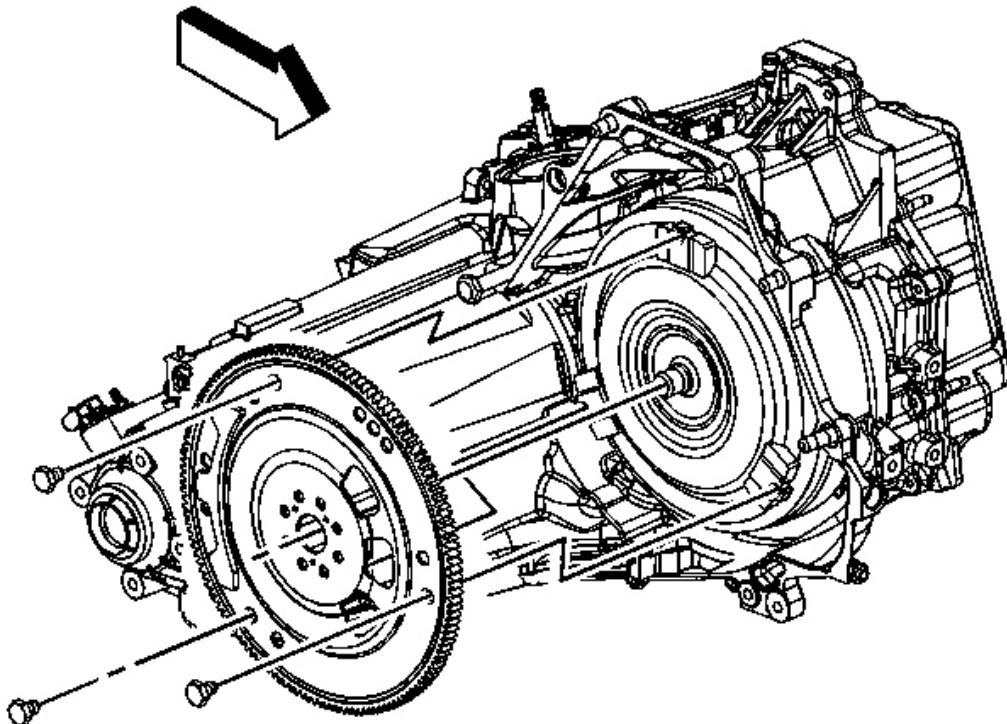
2006 ENGINE Engine Mechanical - 3.8L - Lucerne



**Fig. 304: View Of Transaxle Brace-To-Transaxle Bolts**  
Courtesy of GENERAL MOTORS CORP.

65. Install the transaxle brace to transaxle bolts (1).

**Tighten:** Tighten the bolts to 50 N.m (37 lb ft).



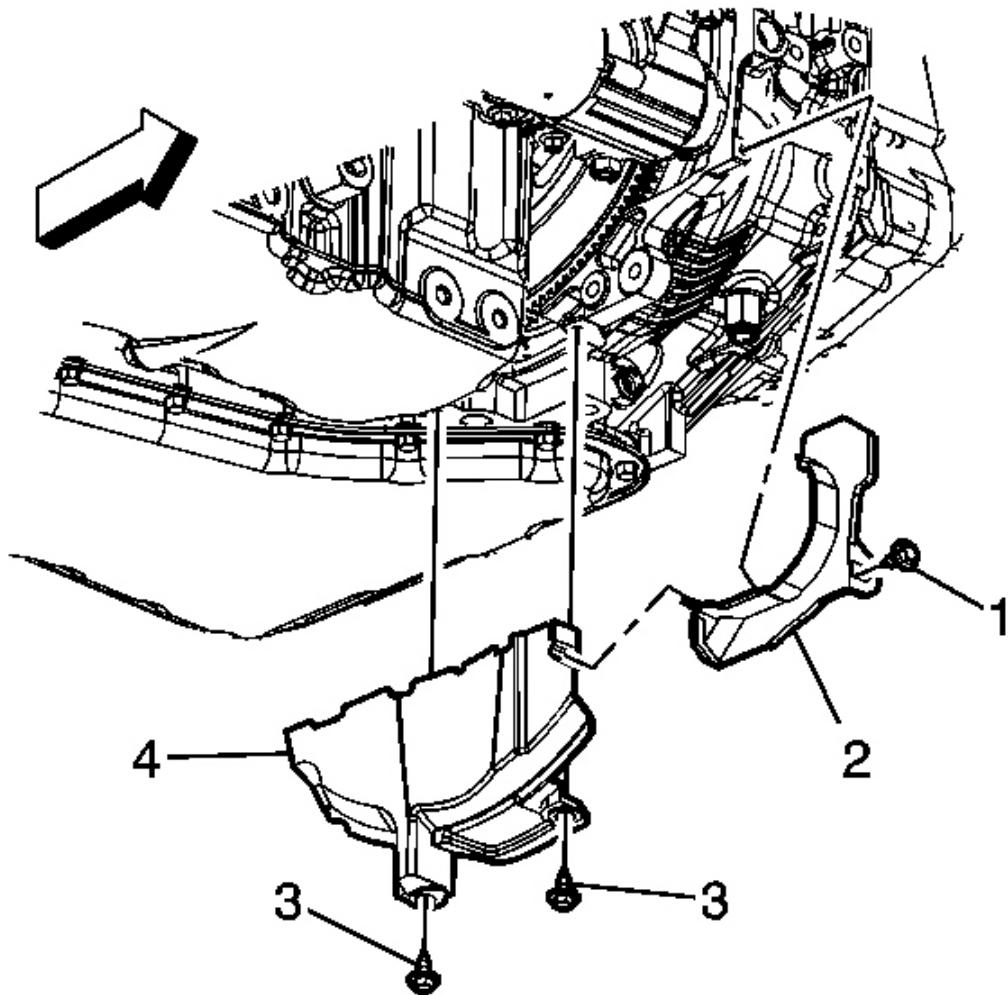
**Fig. 305: Identifying Torque Converter Bolts**

Courtesy of GENERAL MOTORS CORP.

66. Align the mark on the torque converter to the mark on the flywheel.
67. Install the torque converter bolts. (engine shown removed for clarity).

**Tighten:** Tighten the bolts to 50 N.m (37 lb ft).

68. Install the starter motor. Refer to **Starter Motor Replacement (RPO L26)** or **Starter Motor Replacement (RPO LD8)**.



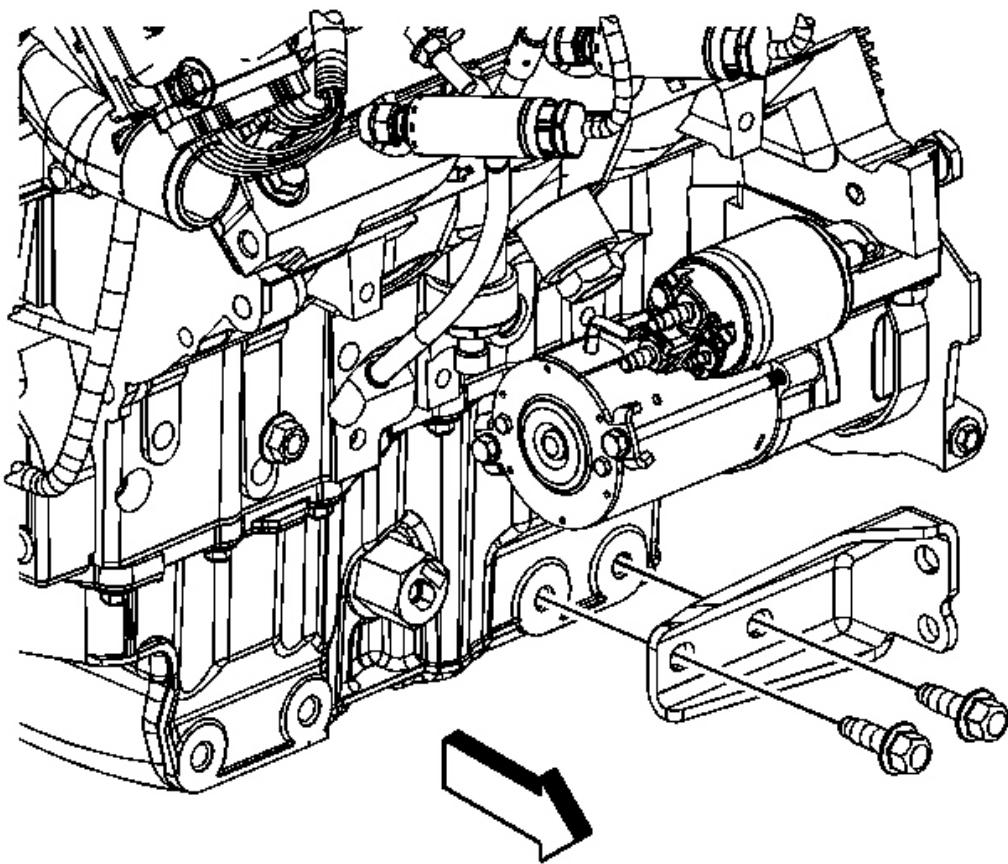
**Fig. 306: Identifying Transaxle Converter Cover**  
Courtesy of GENERAL MOTORS CORP.

69. Position the rear transaxle converter cover (4).
70. Install the rear transaxle converter cover bolts (3).

**Tighten:** Tighten the bolts to 7.5 N.m (66 lb in).

71. Position the front transaxle converter cover (2).
72. Install the front transaxle converter cover bolt (1).

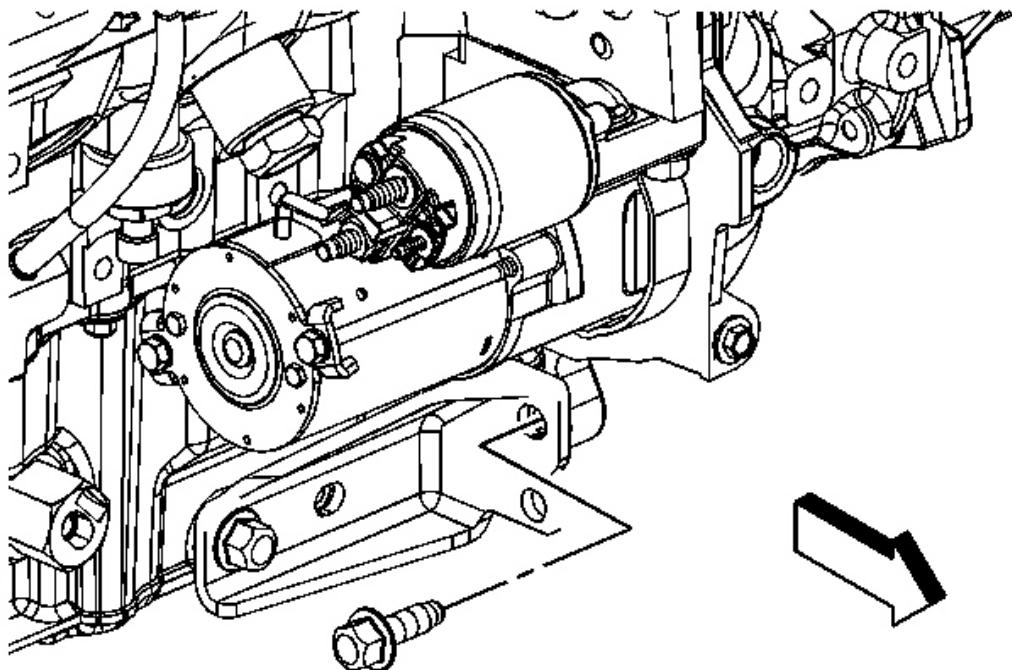
**Tighten:** Tighten the bolt to 7.5 N.m (66 lb in).



**Fig. 307: Identifying Transaxle Brace & Bolts**  
Courtesy of GENERAL MOTORS CORP.

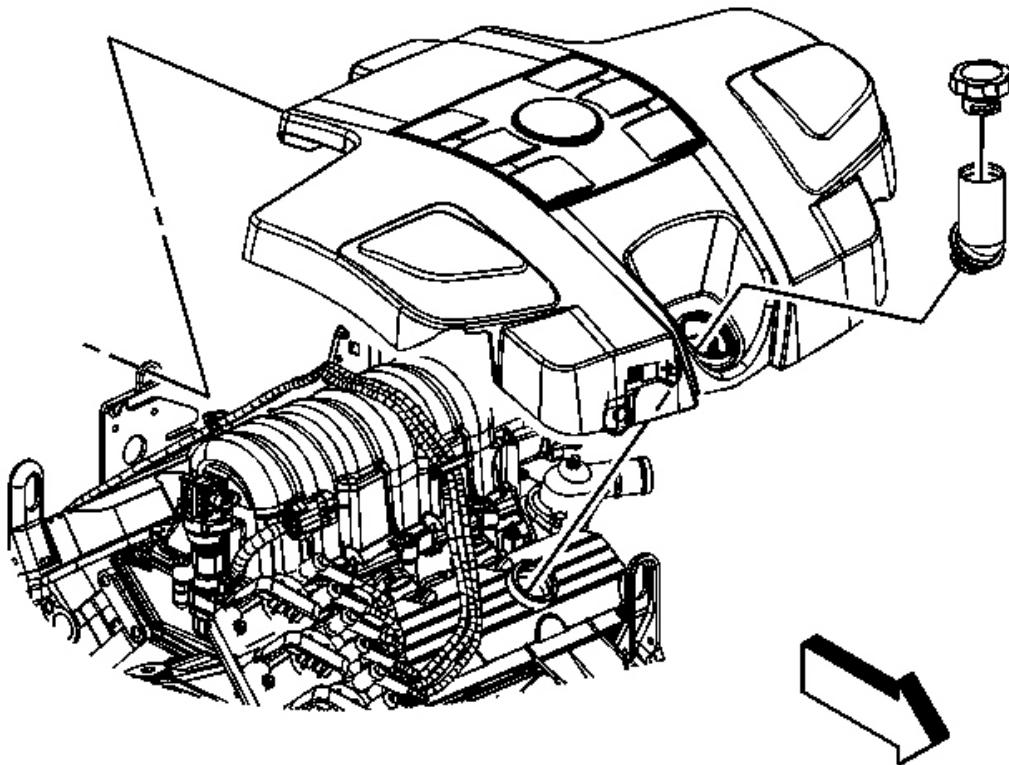
73. Position the transaxle brace and install the brace to oil pan bolts.

**Tighten:** Tighten the bolts to 50 N.m (37 lb ft).



**Fig. 308: Identifying Transaxle Brace-To-Transaxle & Bolts**  
Courtesy of GENERAL MOTORS CORP.

74. Install the transaxle brace to transaxle bolts.  
**Tighten:** Tighten the bolts to 50 N.m (37 lb ft).
75. Lower the vehicle.
76. Remove the oil fill tube from the valve rocker cover.



**Fig. 309: View Of Intake Manifold Cover**

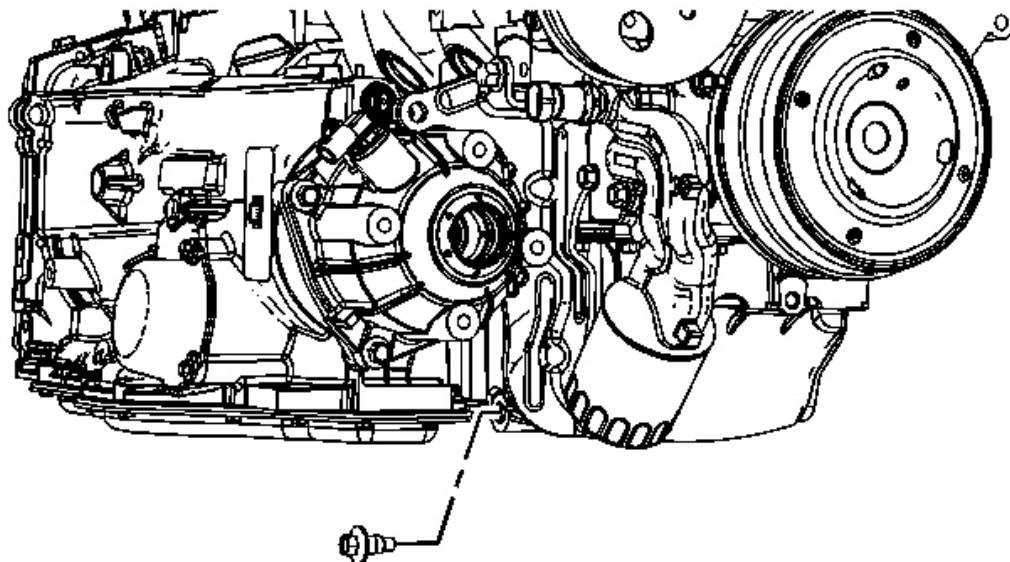
Courtesy of GENERAL MOTORS CORP.

77. Insert the tab on the rear of the intake manifold cover through the engine bracket.
78. Align the hole in the intake manifold cover with the oil fill tube hole in the valve rocker cover.
79. Insert the oil fill tube into the valve rocker cover and twist clockwise in order to lock the detent on the tube into the notch in the cover.
80. Install the hood. Refer to **Hood Replacement** .
81. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
82. Fill the crankcase with oil. Refer to **Engine Oil and Oil Filter Replacement** .
83. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** or **Cooling System Draining and Filling (Vac-N-Fill)** .

84. Perform the CKP system variation learn procedure. Refer to [\*\*Crankshaft Position System Variation Learn\*\*](#).
85. Start the vehicle and inspect for leaks.

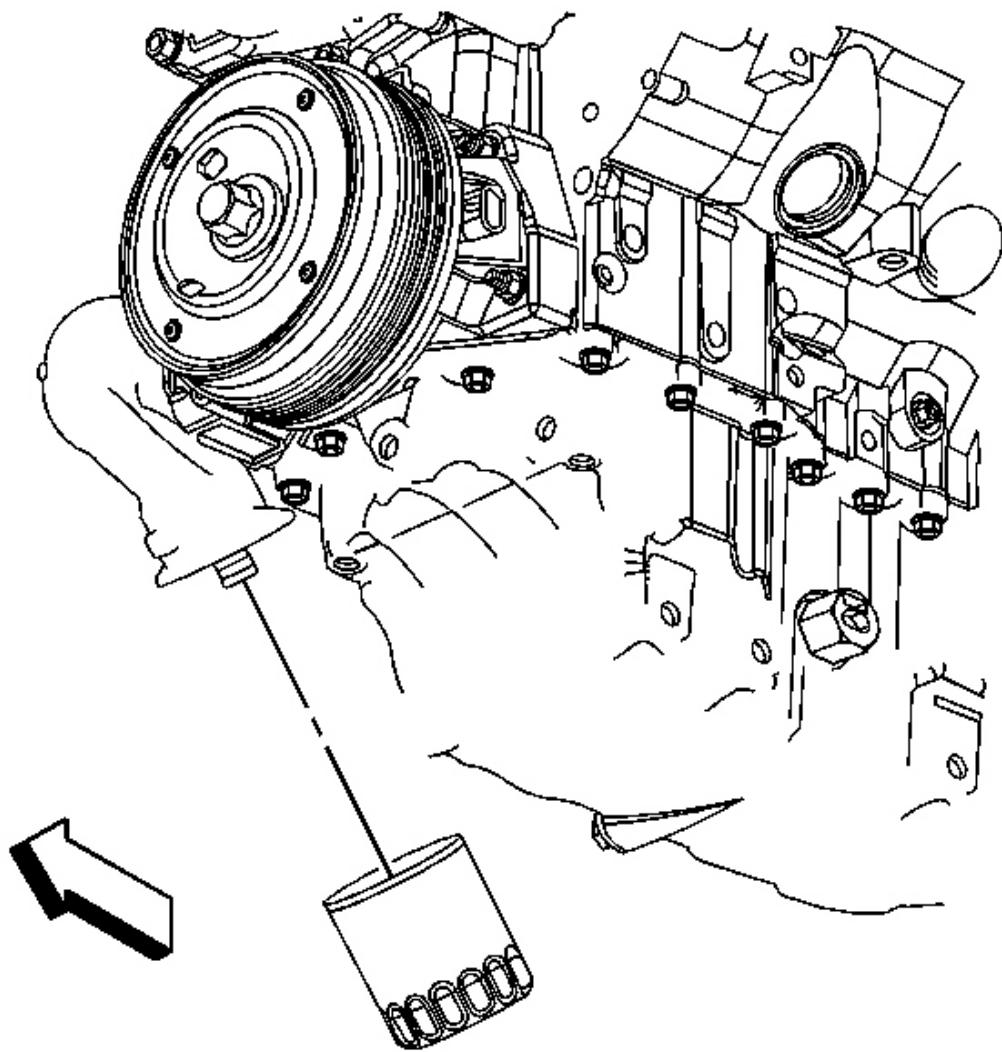
## ENGINE OIL AND OIL FILTER REPLACEMENT

### Removal Procedure



**Fig. 310: Identifying Oil Pan Drain Plug**  
Courtesy of GENERAL MOTORS CORP.

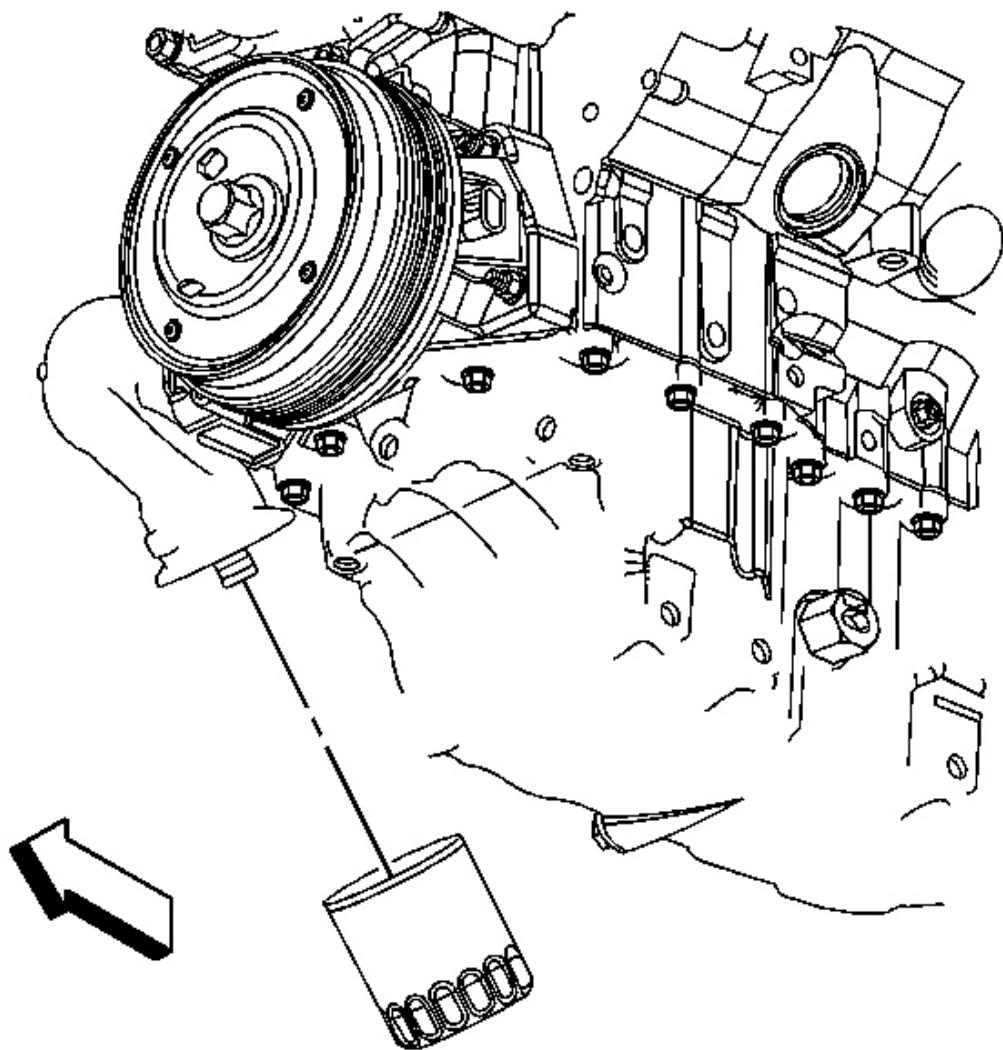
1. Raise and support the vehicle. Refer to [\*\*Lifting and Jacking the Vehicle\*\*](#).
2. Position a suitable drain pan under the oil pan drain plug.
3. Remove the oil pan drain plug.
4. Allow the oil to drain completely.
5. Clean and inspect the oil pan drain plug, replace if necessary.
6. Clean and inspect the oil pan drain plug sealing surface, replace the oil pan if necessary.
7. Wipe and remaining oil from the drain plug hole and reinstall the oil pan drain plug until snug.



**Fig. 311: Identifying Oil Filter**

Courtesy of GENERAL MOTORS CORP.

8. Position a suitable drain pan under the oil filter.
9. Remove the oil filter.
10. Ensure that the oil filter gasket is still on the old filter, if not remove the oil filter gasket from the adapter.



**Fig. 312: Identifying Oil Filter**

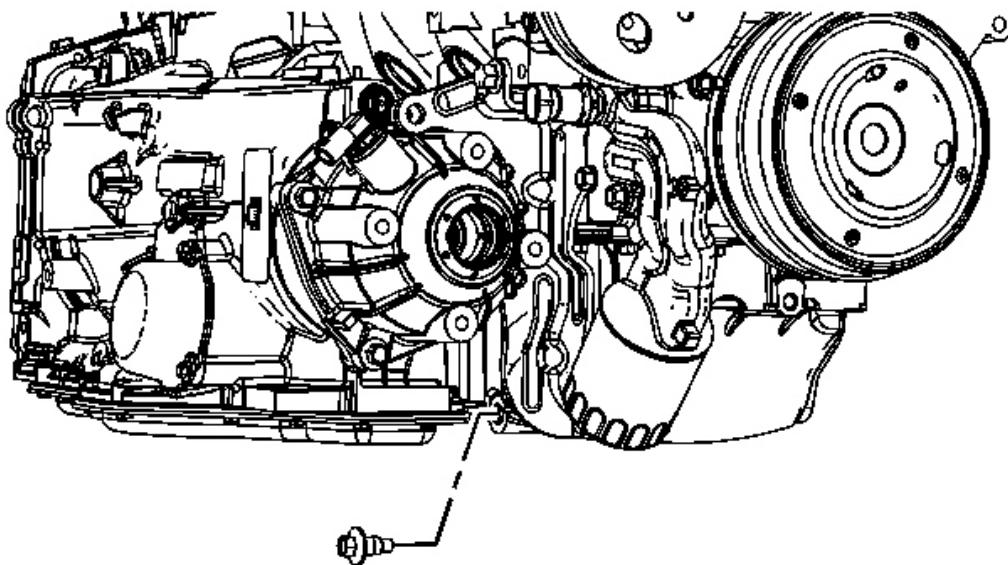
Courtesy of GENERAL MOTORS CORP.

1. Apply clean engine oil to the NEW oil filter gasket.

**NOTE: Refer to Fastener Notice .**

2. Install the NEW oil filter.

**Tighten:** Tighten the new oil filter to 3/4 to 1 full turn, after the oil filter gasket contacts the adapter.



**Fig. 313: Identifying Oil Pan Drain Plug**  
Courtesy of GENERAL MOTORS CORP.

3. Tighten the oil pan drain plug.

**Tighten:** Tighten the plug to 30 N.m (22 lb ft).

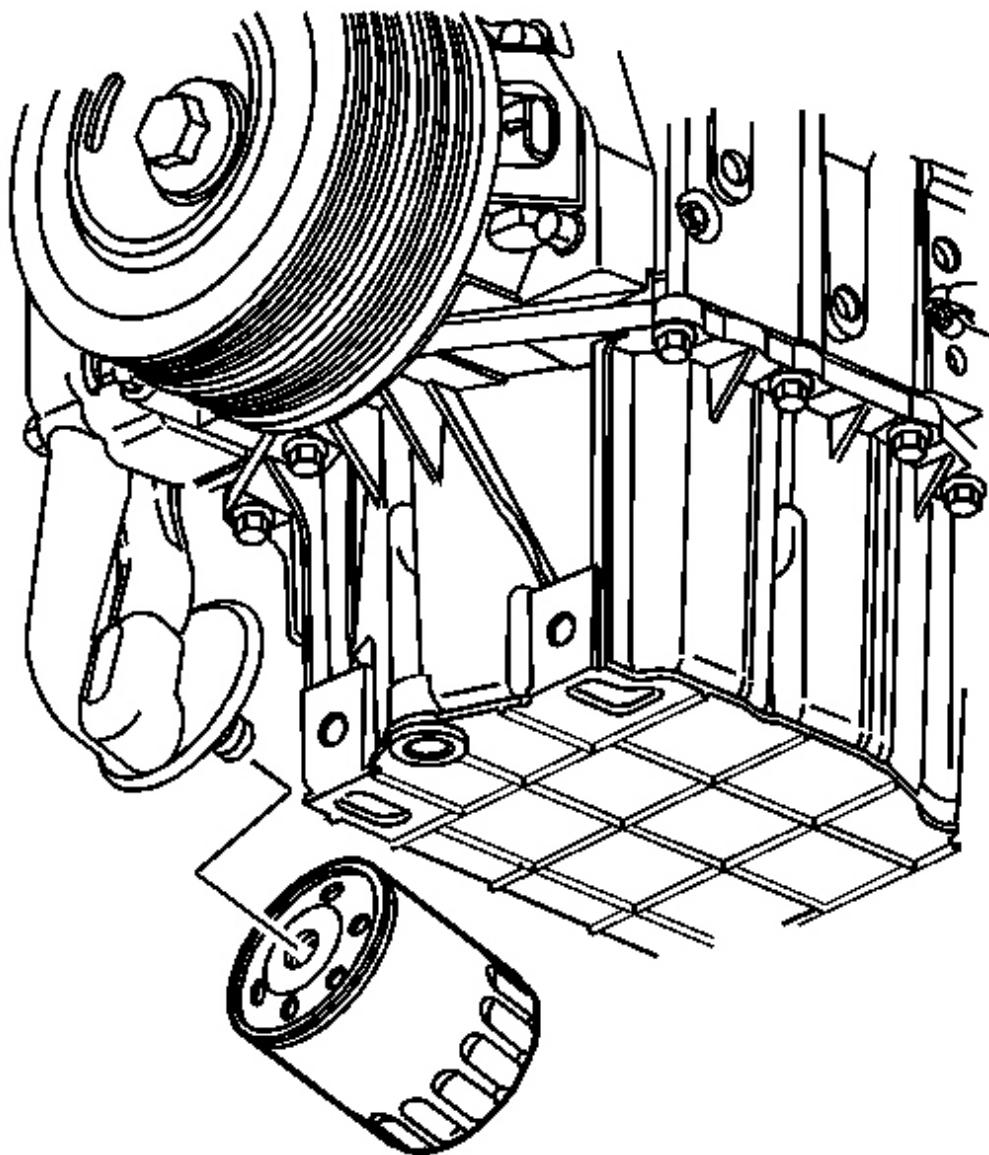
4. Remove the oil drain pan from under the vehicle.
5. Lower the vehicle.
6. Fill the engine with new engine oil. Refer to Approximate Fluid Capacities and Fluid and Lubricant Recommendations .
7. Start the engine.
8. Inspect for oil leaks after engine start up.
9. Turn off the engine and allow the oil a few minutes to drain back into the oil pan.
10. Remove the oil level indicator from the oil indicator tube.
11. Clean off the indicator end of the oil level indicator with a clean paper towel or cloth.

12. Install the oil level indicator into the oil level indicator tube until the oil level indicator handle contacts the top of the oil level indicator tube.
13. Again, remove the oil level indicator from the oil level indicator tube keeping the tip of the oil level indicator down.
14. Check the level of the engine oil on the oil level indicator.
15. If necessary, adjust the oil level by adding or draining oil.
16. Check for oil leaks.

## **REPAIR INSTRUCTIONS - OFF VEHICLE**

### **DRAINING FLUIDS AND OIL FILTER REMOVAL**

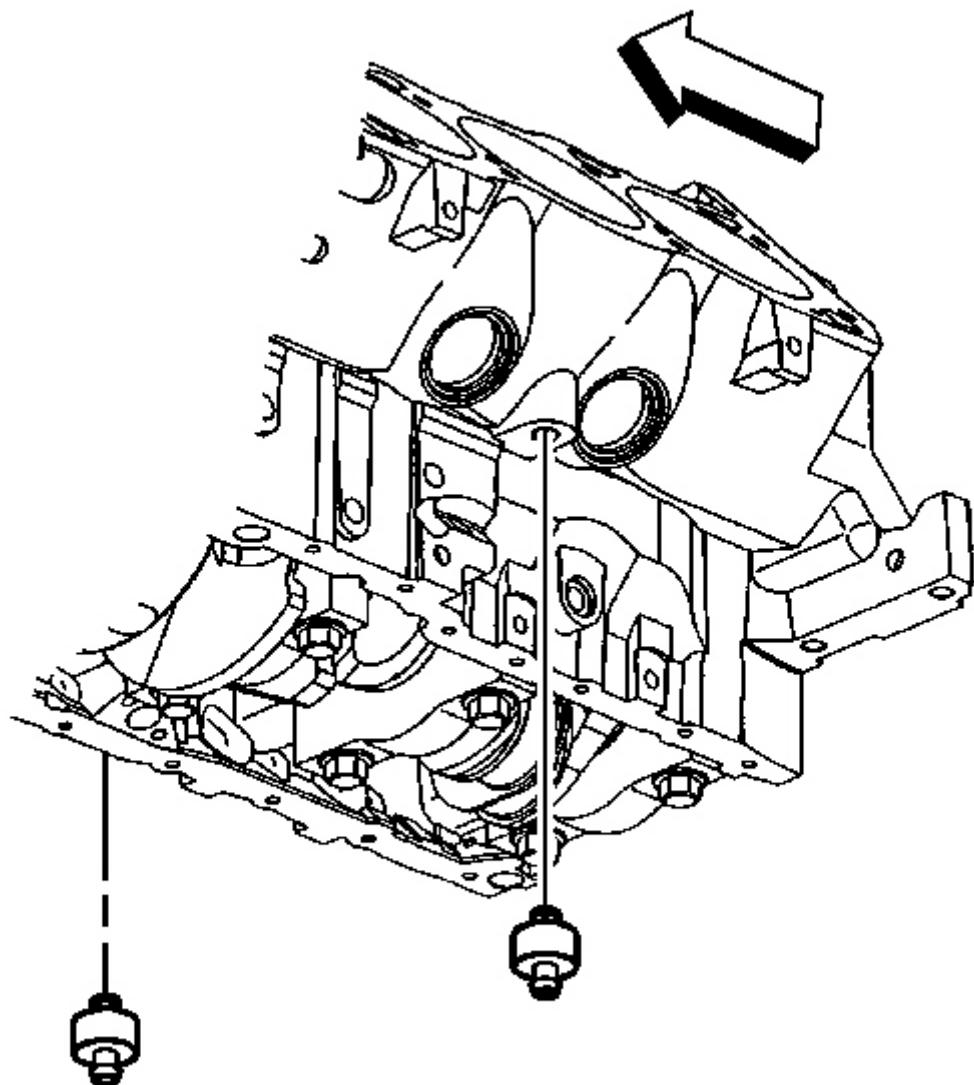
#### **Removal Procedure**



**Fig. 314: Identifying Oil Filter Location**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil drain plug.
2. Drain the engine oil.

3. Remove the oil filter.



**Fig. 315: Identifying Knock Sensors**  
Courtesy of GENERAL MOTORS CORP.

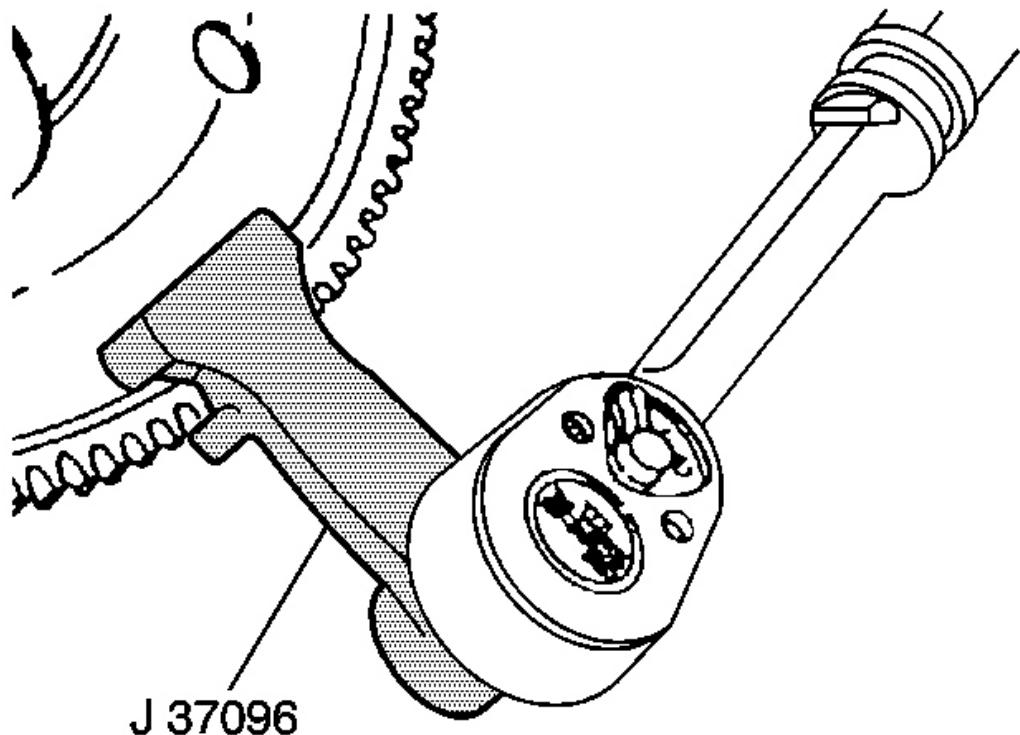
4. Remove the knock sensors.
5. Drain the coolant.

## CRANKSHAFT BALANCER REMOVAL

### Tools Required

- **J 37096** Flywheel Holder. See Special Tools.
- **J 38197-A** Crankshaft Balancer Remover. See Special Tools.

### Removal Procedure



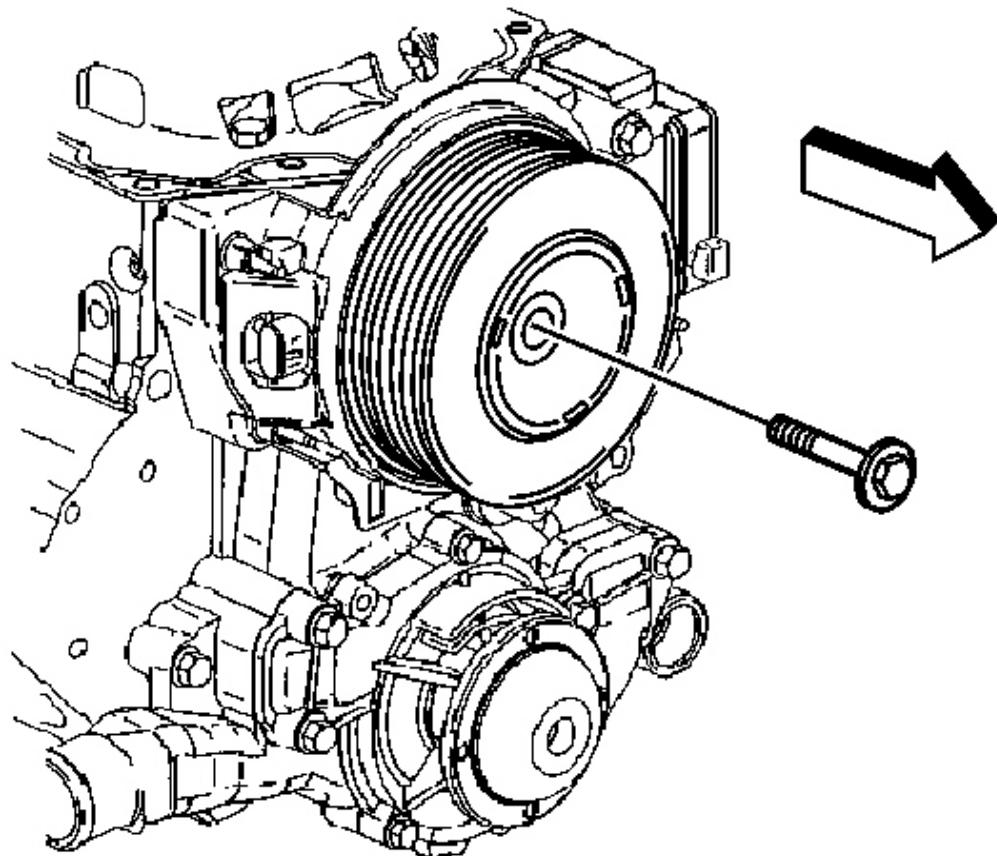
**Fig. 316: Holding Flywheel**

Courtesy of GENERAL MOTORS CORP.

1. Use **J 37096** in order to hold the flywheel. See Special Tools.

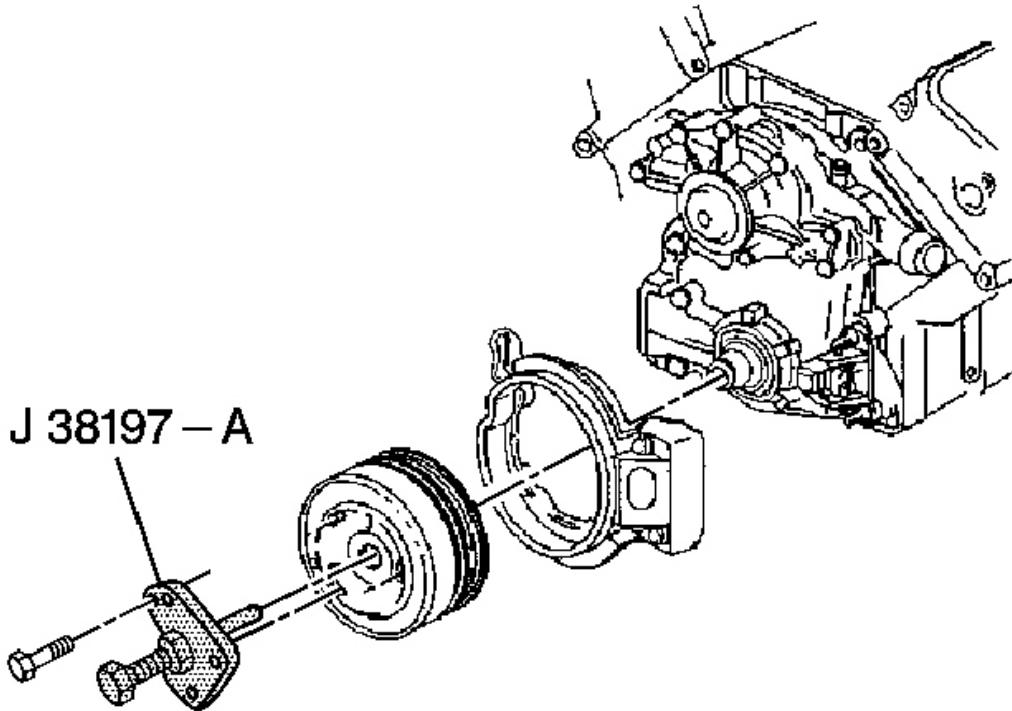
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**Fig. 317: View Of Crankshaft Balancer Bolt**  
Courtesy of GENERAL MOTORS CORP.

2. Remove the crankshaft balancer bolt.



**Fig. 318: Removing Crankshaft Balancer Using J 38197-A**

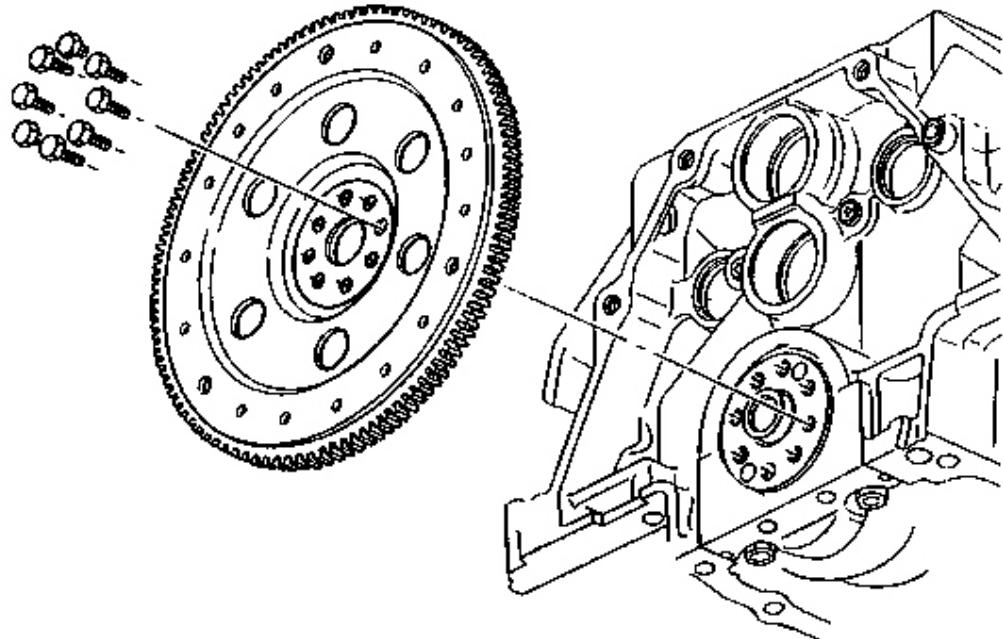
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT: Do not separate the crankshaft pulley from the crankshaft balancer. Service the crankshaft pulley and the crankshaft balancer as an assembly.**

3. Use the **J 38197-A** in order to remove the crankshaft balancer. See **Special Tools**.
  1. Invert J 38197-2 so the leg of the tool is facing away from the crankshaft balancer.
  2. Install the silver screws J 38197-4 to the crankshaft balancer.
  3. Turn J 38197-1 to remove the crankshaft balancer from the crankshaft.
  4. Remove J 38197-1, J 38197-2 and J 38197-4 from the crankshaft balancer.

## ENGINE FLYWHEEL REMOVAL

### Removal Procedure



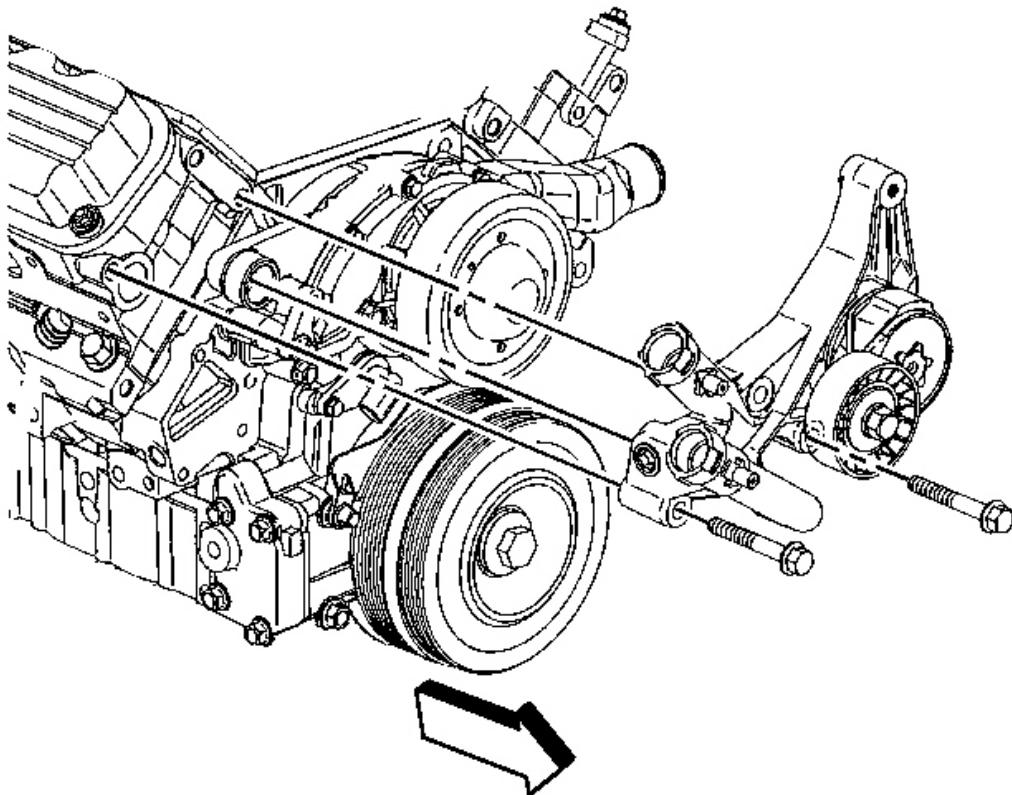
**Fig. 319: Engine Flywheel & Bolts**

Courtesy of GENERAL MOTORS CORP.

1. Remove the flywheel bolts. Discard the bolts.
2. Remove the flywheel.

#### **DRIVE BELT TENSIONER REMOVAL**

##### **Removal Procedure**



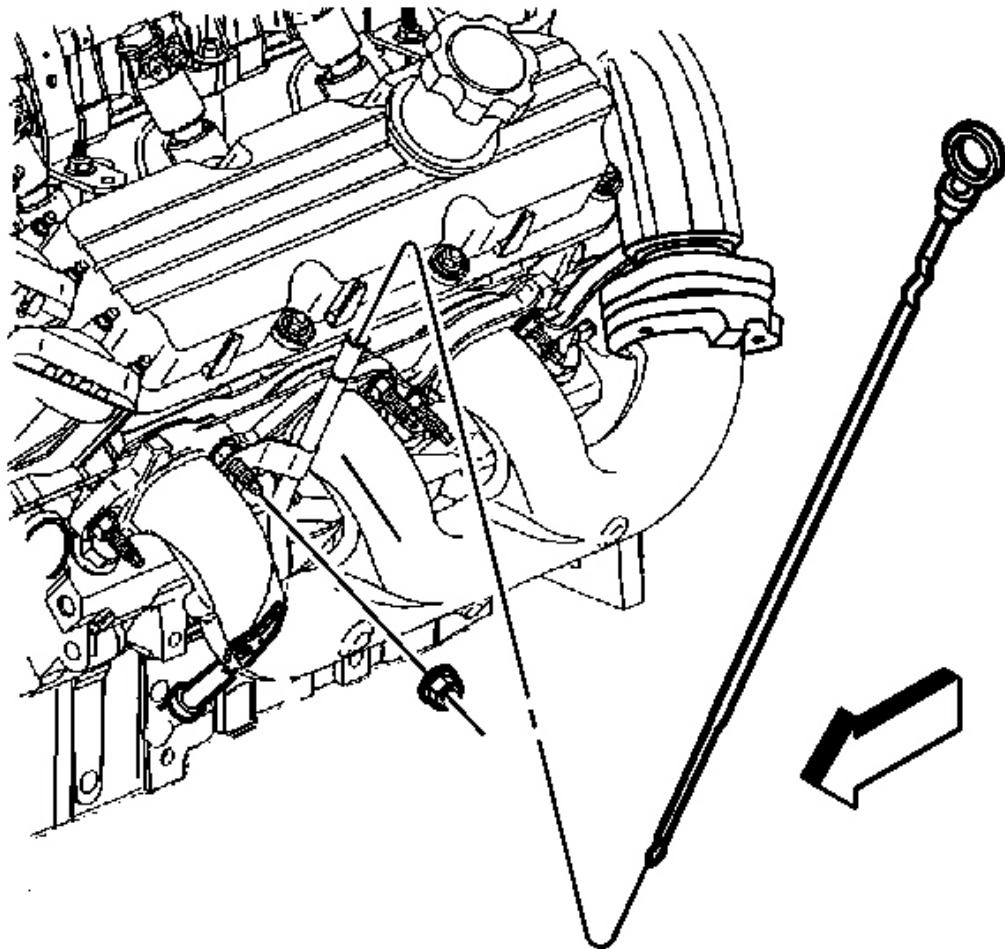
**Fig. 320: Drive Belt Tensioner Bracket & Bolts**

Courtesy of GENERAL MOTORS CORP.

1. Remove the drive belt tensioner bracket bolts.
2. Remove the drive belt tensioner bracket.

#### **OIL LEVEL INDICATOR AND TUBE REMOVAL**

##### **Removal Procedure**

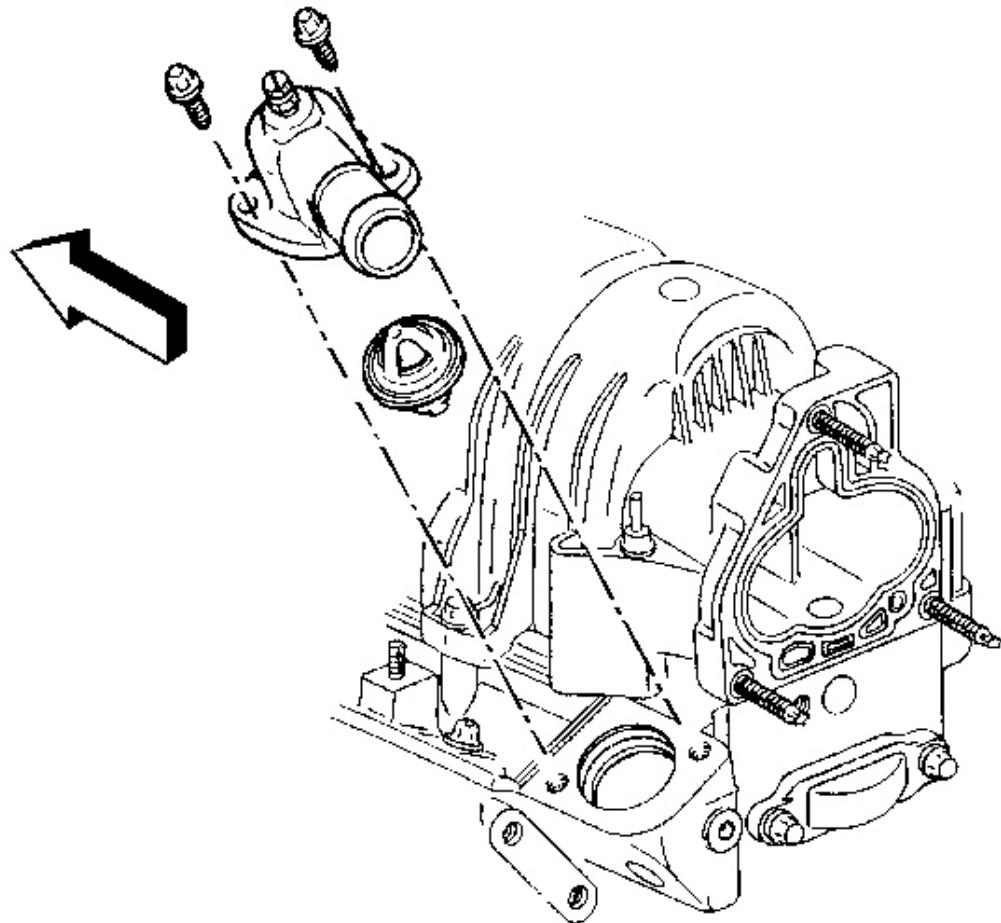


**Fig. 321: View of Oil Level Indicator & Tube**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil level indicator.
2. Remove the oil level indicator tube nut.
3. Remove the oil level indicator tube.

#### **WATER OUTLET AND THERMOSTAT REMOVAL**

##### **Removal Procedure**



**Fig. 322: Identifying Water Outlet & Thermostat**  
Courtesy of GENERAL MOTORS CORP.

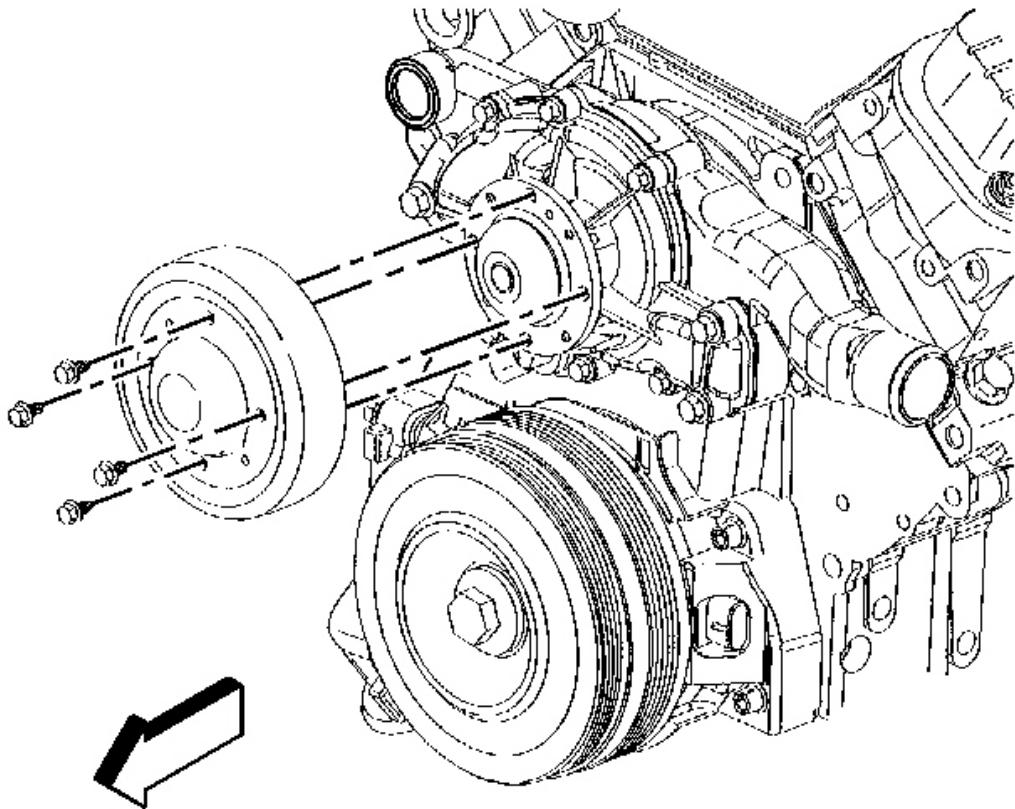
1. Remove the water outlet bolts.
2. Remove the water outlet.
3. Remove the thermostat.

## **WATER PUMP REMOVAL**

### **Removal Procedure**

## 2006 Buick Lucerne CXS

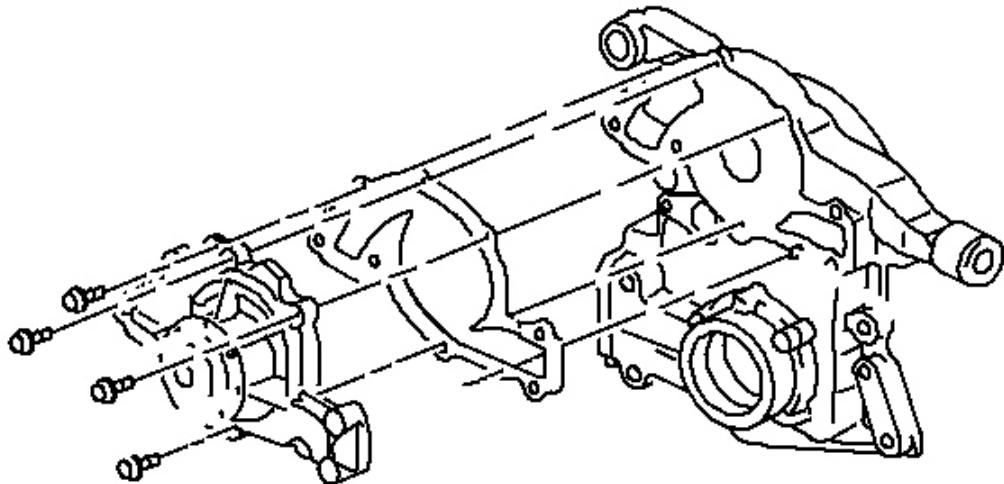
2006 ENGINE Engine Mechanical - 3.8L - Lucerne



**Fig. 323: Identifying Water Pump Pulley Bolts**

Courtesy of GENERAL MOTORS CORP.

1. Remove the water pump pulley bolts.
2. Remove the water pump pulley.

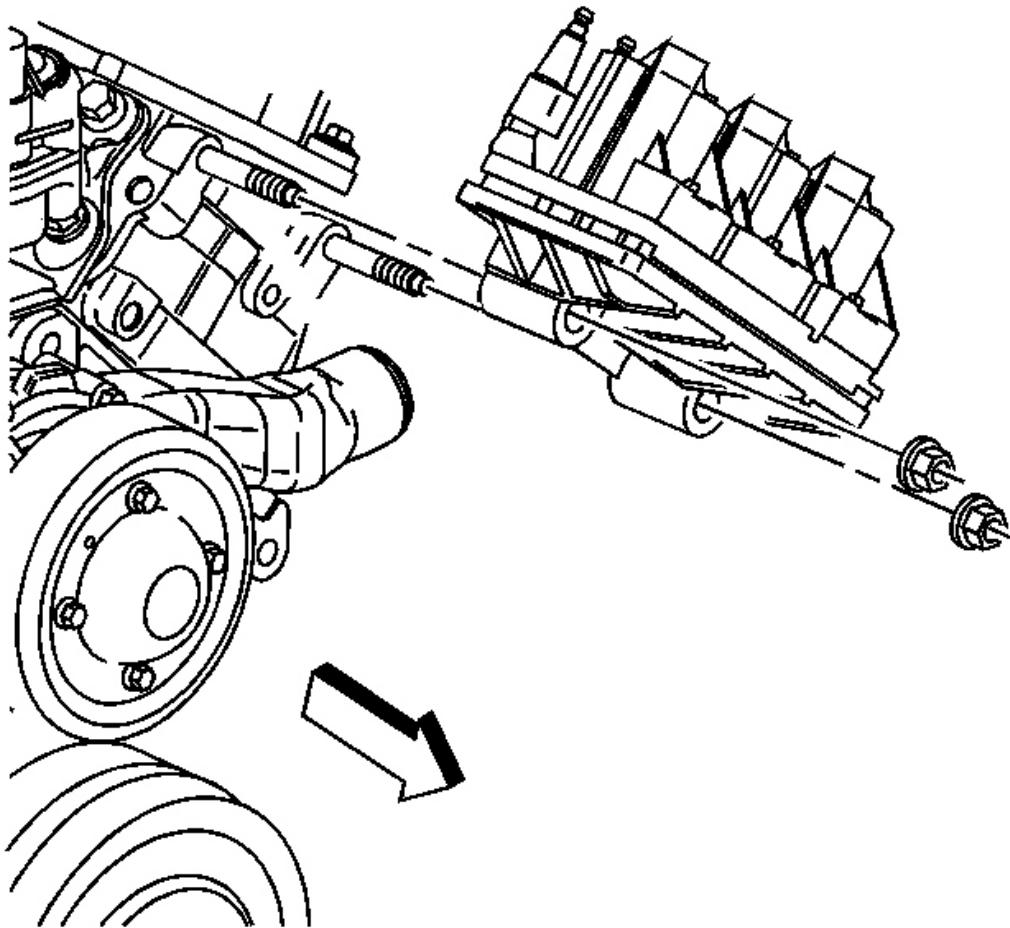


**Fig. 324: Water Pump, Bolts & Gasket**  
Courtesy of GENERAL MOTORS CORP.

3. Remove the water pump bolts.
4. Remove the water pump.
5. Remove the water pump gasket.

#### **UPPER INTAKE MANIFOLD REMOVAL**

##### **Removal Procedure**

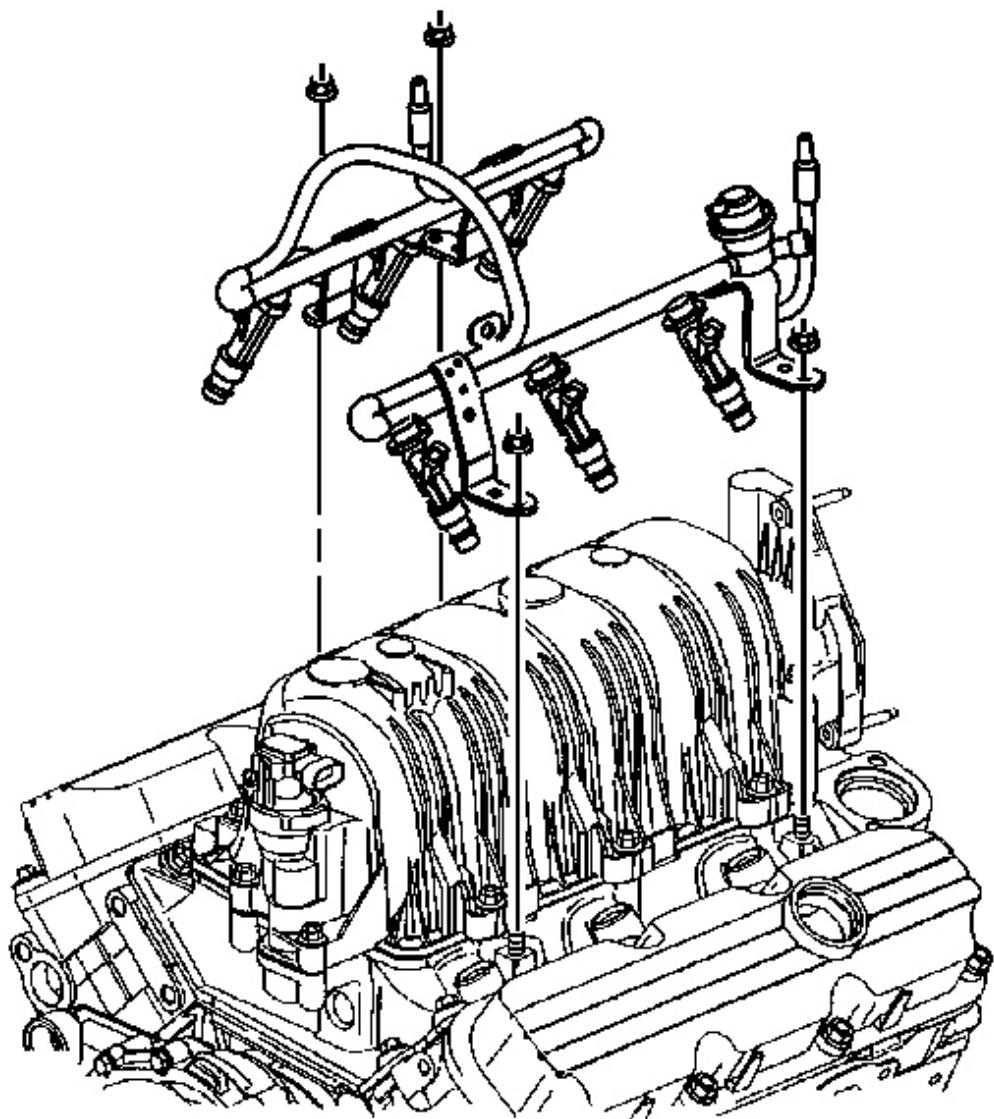


**Fig. 325: Identifying Ignition Control Module Assembly**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the spark plug wires.
2. Disconnect the ignition wires from the fuel injector rail.
3. Disconnect the ignition control module connector from the ignition control module assembly.
4. Remove the ignition control module assembly nuts.
5. Remove the ignition control module assembly.

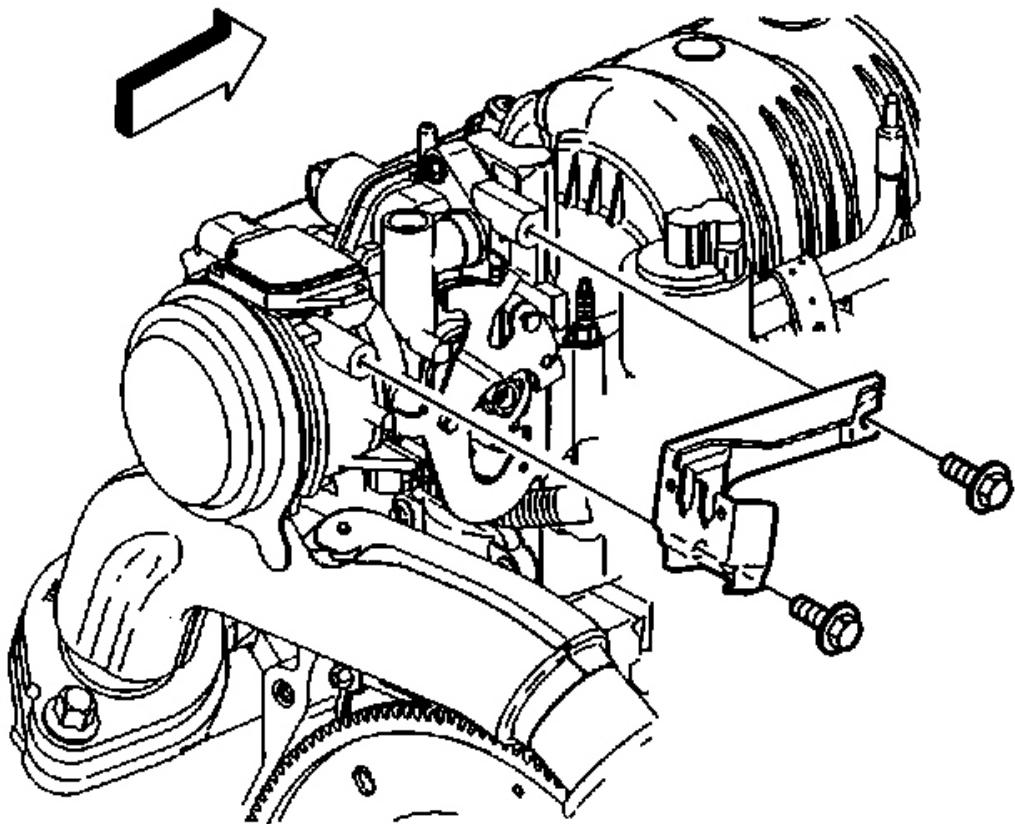
**2006 Buick Lucerne CXS**

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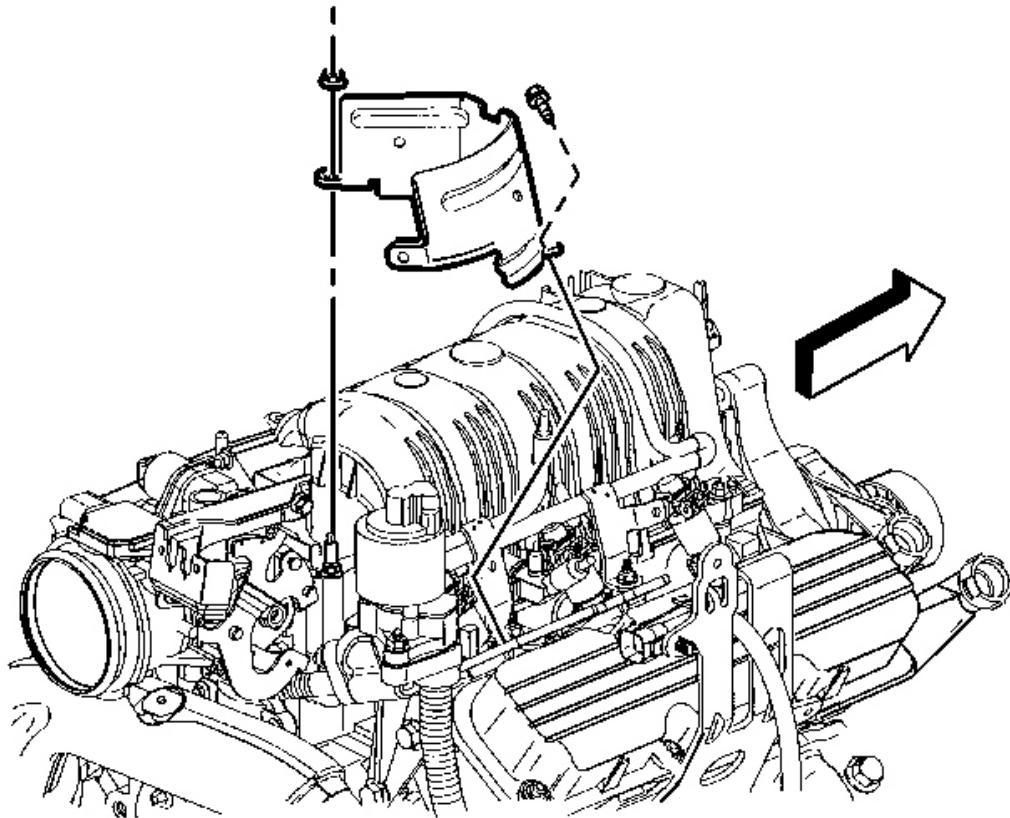
**Fig. 326: Identifying Fuel Injector Rail Bolts**  
Courtesy of GENERAL MOTORS CORP.

6. Remove the fuel injector rail nuts.
7. Remove the fuel injector rail.



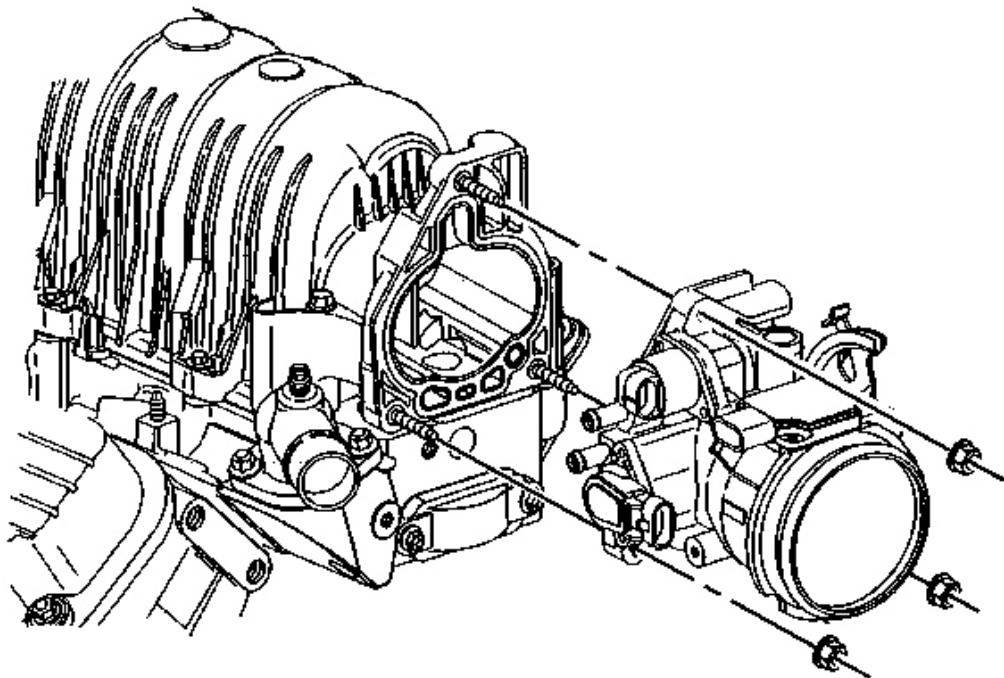
**Fig. 327: Accelerator Control Cable Bracket**  
Courtesy of GENERAL MOTORS CORP.

8. Remove the accelerator control cable bracket bolts.
9. Remove the accelerator control cable bracket from the intake manifold.



**Fig. 328: Engine Wiring Harness Heat Shield**  
Courtesy of GENERAL MOTORS CORP.

10. Remove the engine wiring harness heat shield bolt and nut.
11. Remove the engine wiring harness heat shield.

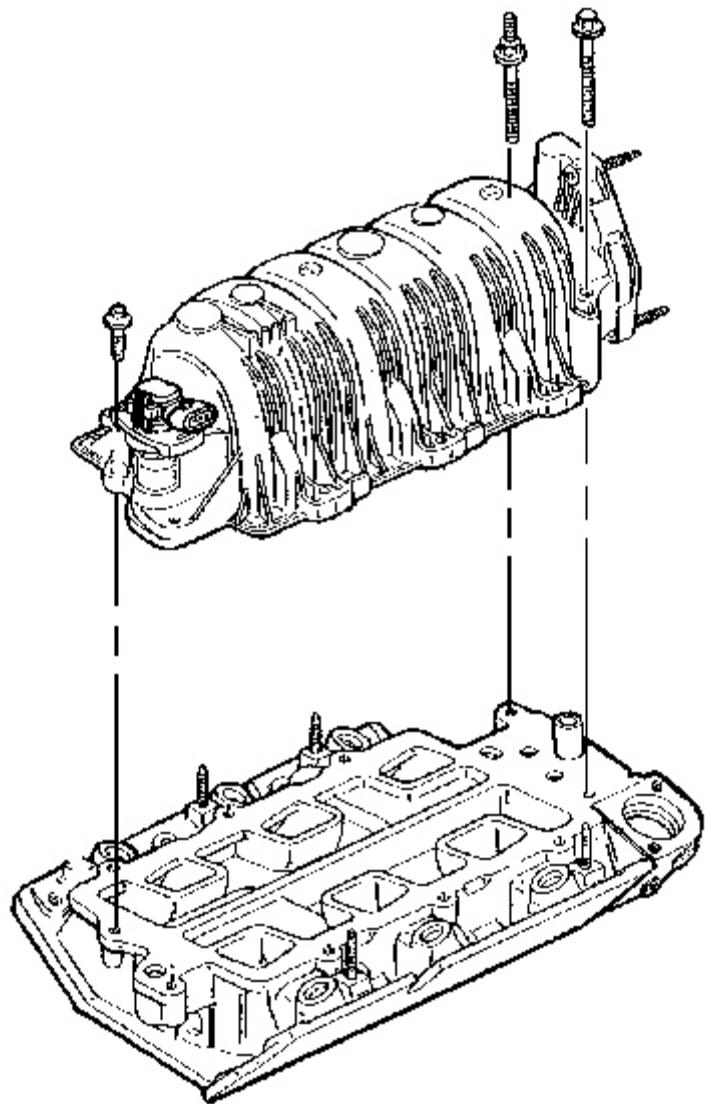


**Fig. 329: Identifying Throttle Body & Gasket**  
Courtesy of GENERAL MOTORS CORP.

12. Remove the throttle body nuts.
13. Remove the throttle body.
14. Remove the throttle body gasket.

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**Fig. 330: Upper Intake Manifold**

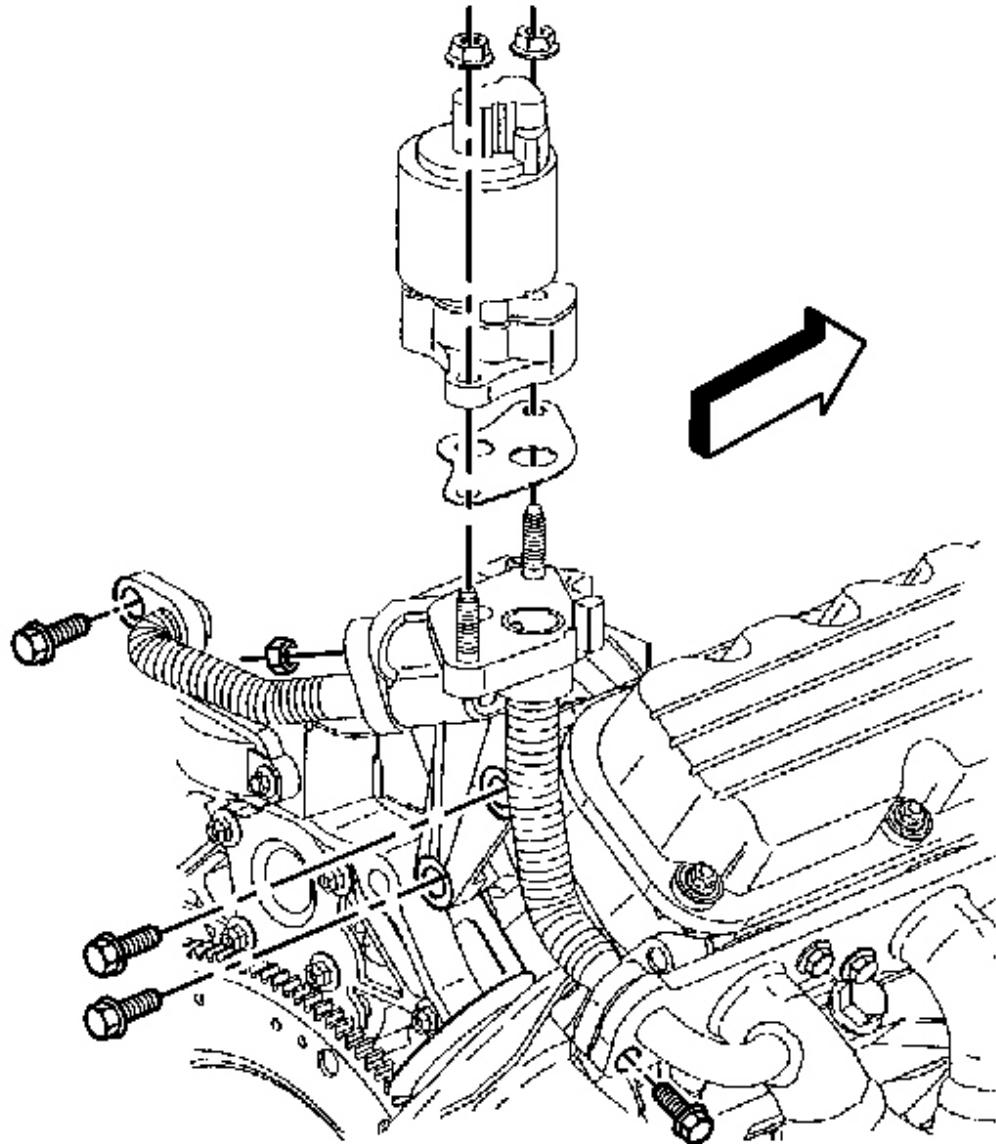
Courtesy of GENERAL MOTORS CORP.

15. Remove the upper intake manifold bolts and nuts.
16. Remove the upper intake manifold.

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#### Removal Procedure



**Fig. 331: View Of EGR Valve Adapter Assembly**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the EGR valve nuts, EGR valve and gasket.

2. Remove the EGR valve adapter inlet pipe bolt from the RH exhaust manifold.
3. Remove the EGR valve outlet pipe bolt, nut and pipe from the lower intake manifold and the EGR valve adapter assembly.
4. Remove the EGR valve adapter assembly bolts.
5. Remove the EGR valve adapter assembly from the cylinder head.

## LOWER INTAKE MANIFOLD REMOVAL

### Removal Procedure

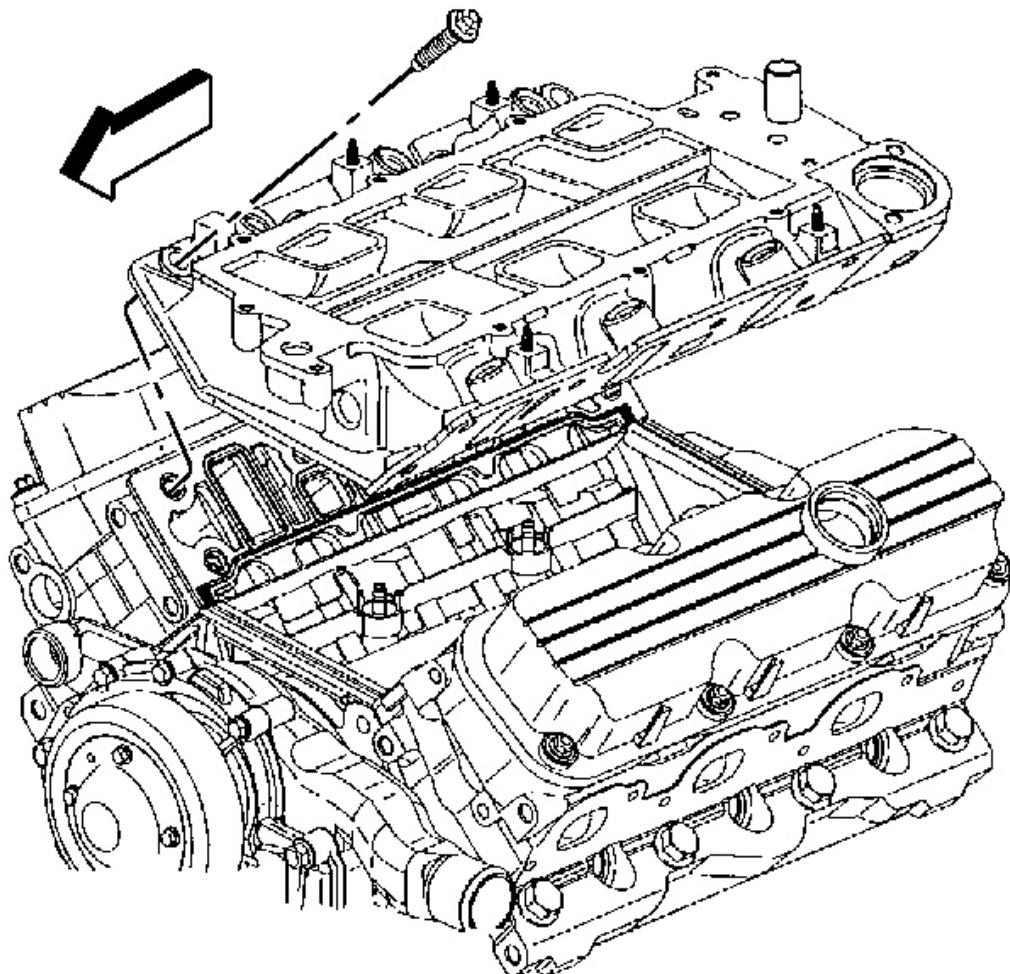


Fig. 332: Lower Intake Manifold

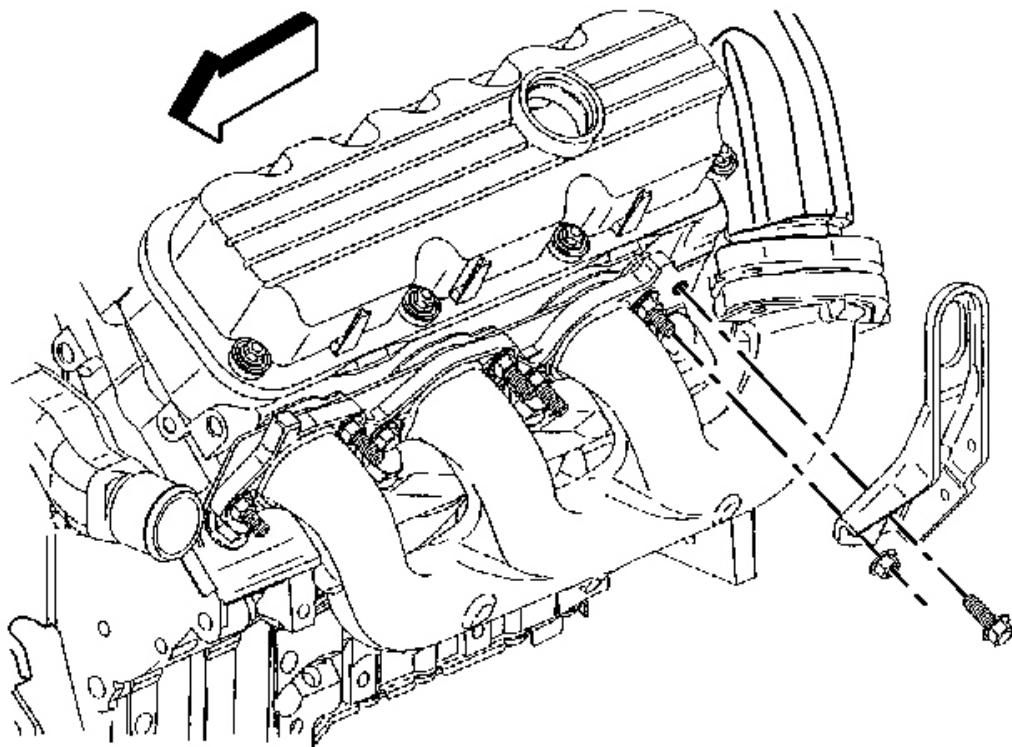
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT: Bolts which fasten the lower intake manifold to the cylinder head are accessible only after the upper intake is removed. The bolts are located in the right front and left rear corners of the lower intake manifold. Remove the upper intake manifold to service the lower intake.**

1. Remove the EGR outlet pipe from the intake manifold.
2. Remove the lower intake manifold bolts.
3. Remove the lower intake manifold.
4. Remove the lower intake manifold gasket.

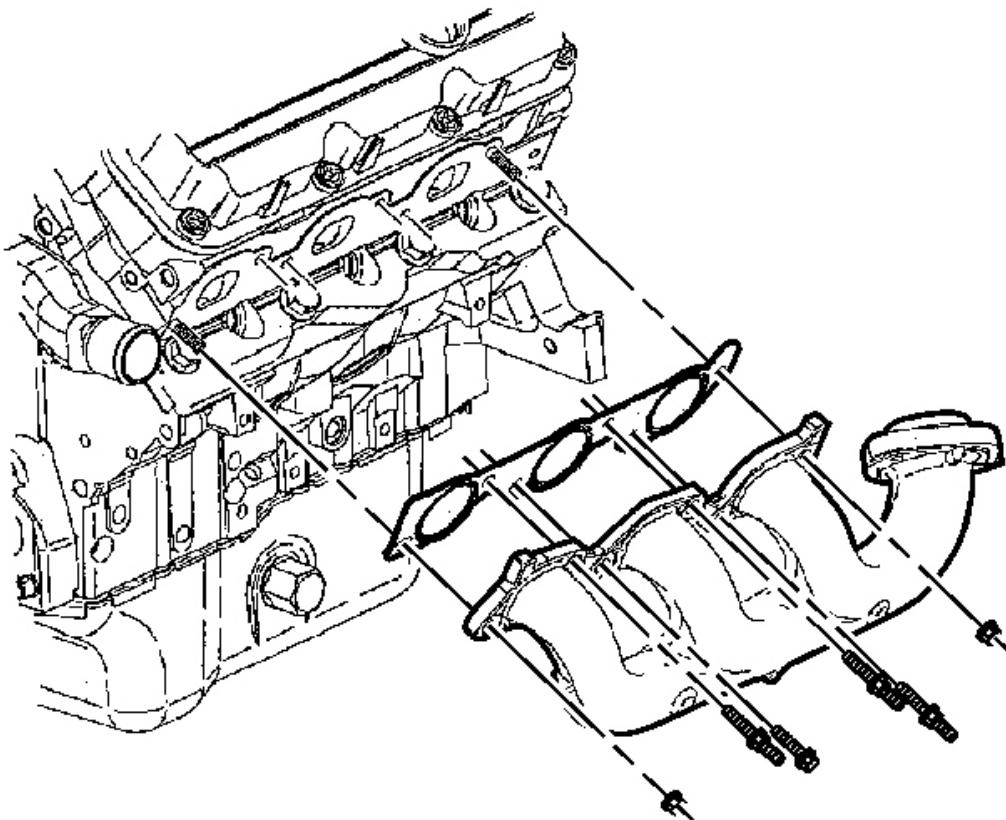
#### **EXHAUST MANIFOLD REMOVAL - LEFT SIDE**

##### **Removal Procedure**



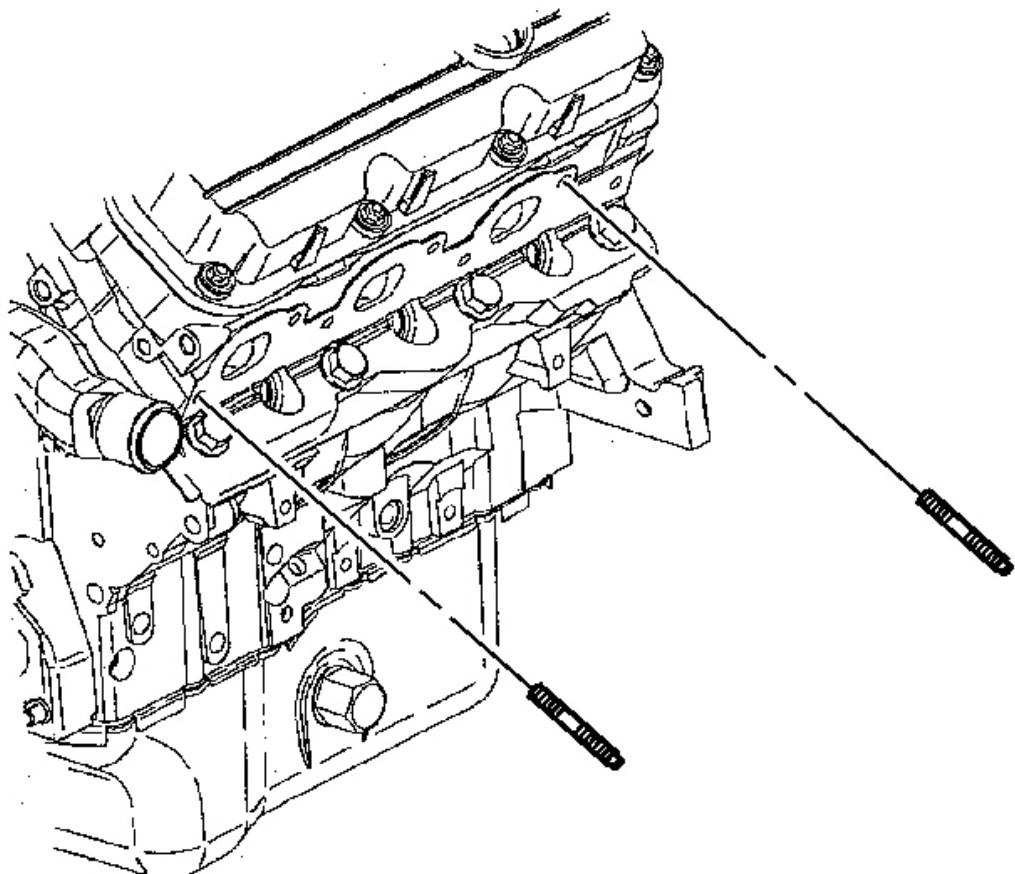
**Fig. 333: Locating Left Engine Lift Hook**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the left engine lift hook nut and bolt.
2. Remove the left engine lift hook.
3. Remove the left side spark plugs.



**Fig. 334: Removing/Installing Left Exhaust Manifold**  
Courtesy of GENERAL MOTORS CORP.

4. Remove the exhaust manifold bolt and studs.
5. Remove the exhaust manifold.
6. Remove the exhaust manifold gasket.



**Fig. 335: Left Exhaust Manifold Studs**  
Courtesy of GENERAL MOTORS CORP.

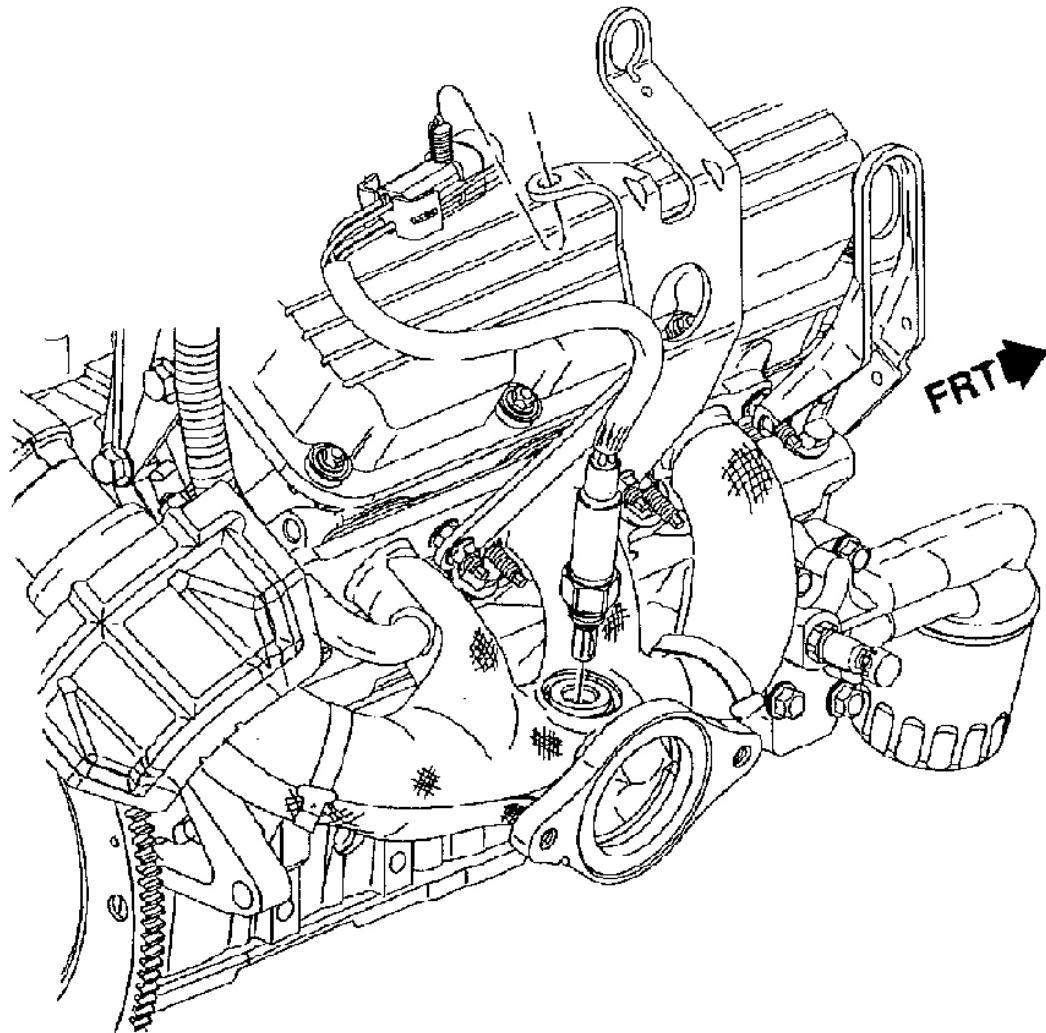
7. Remove the exhaust manifold studs.

#### **EXHAUST MANIFOLD REMOVAL - RIGHT SIDE**

##### **Removal Procedure**

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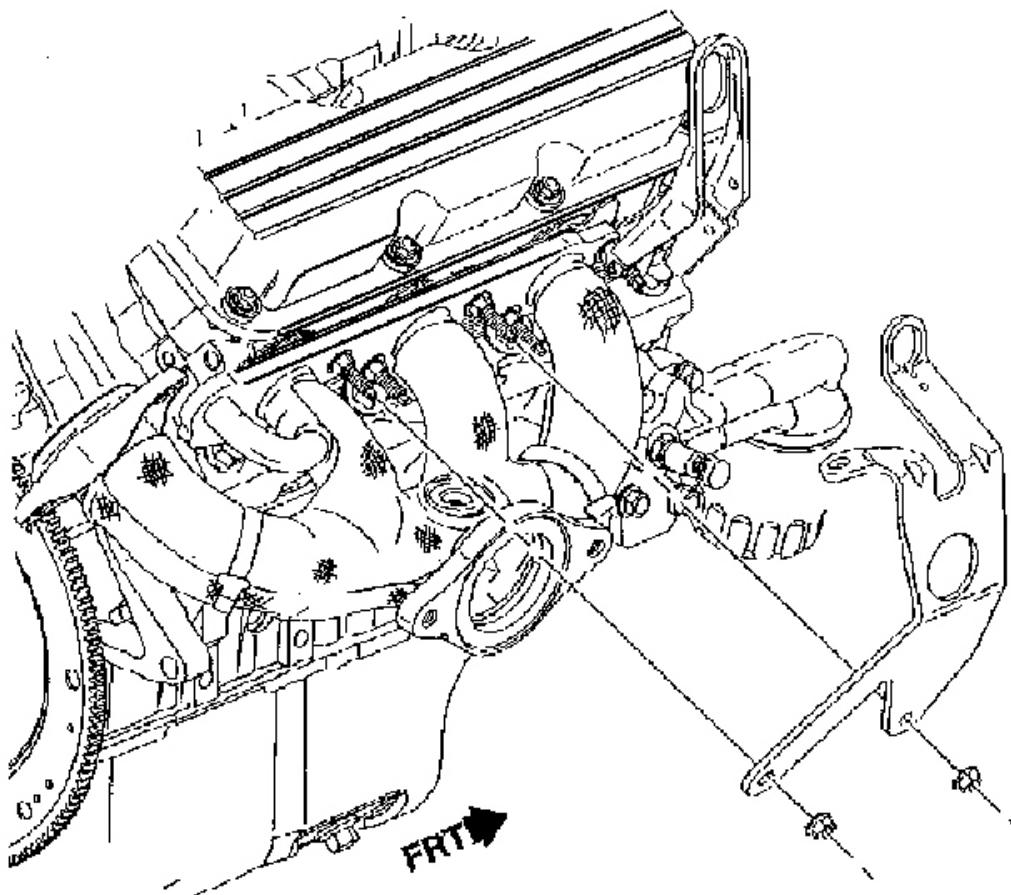


**Fig. 336: View of Heated Oxygen Sensor Lead**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the heated oxygen sensor lead.

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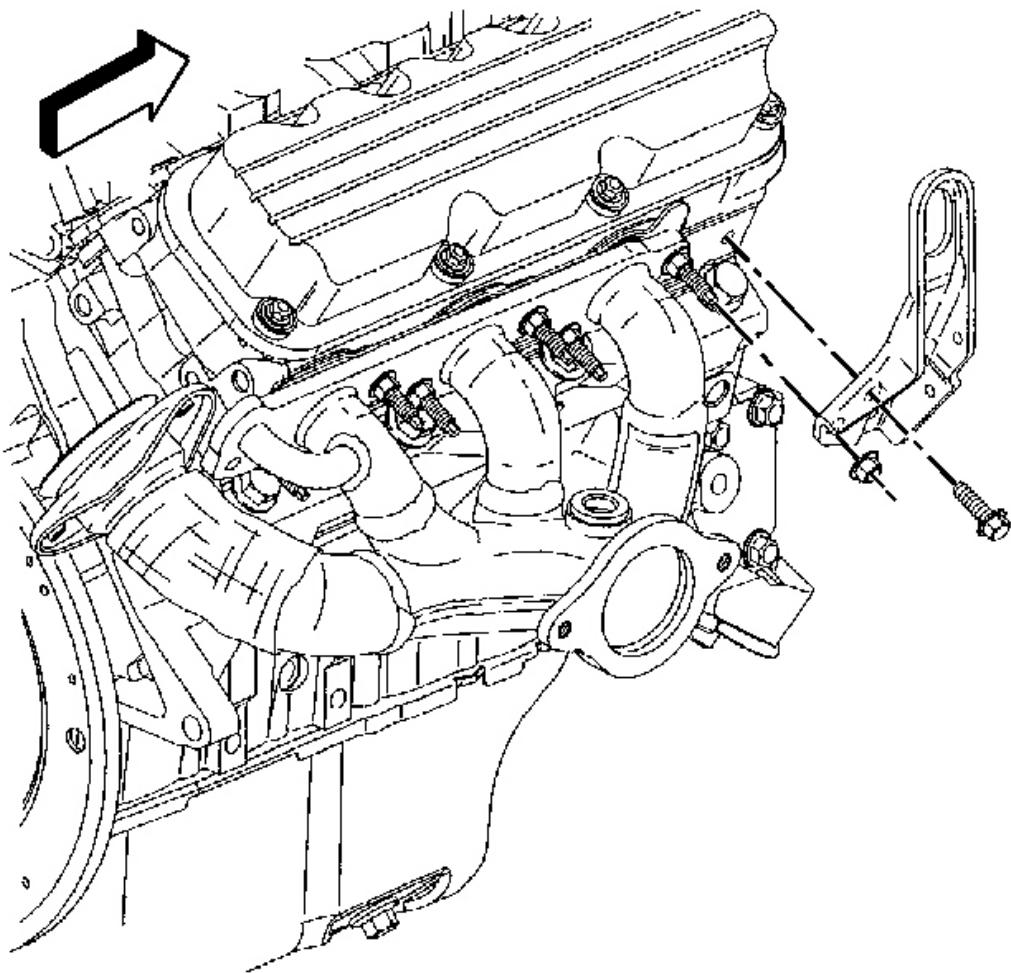


**Fig. 337: View of Fuel Injector Sight Shield Mounting Bracket**  
**Courtesy of GENERAL MOTORS CORP.**

2. Remove the fuel injector sight shield mounting bracket nuts.
3. Remove the fuel injector sight shield mounting bracket.

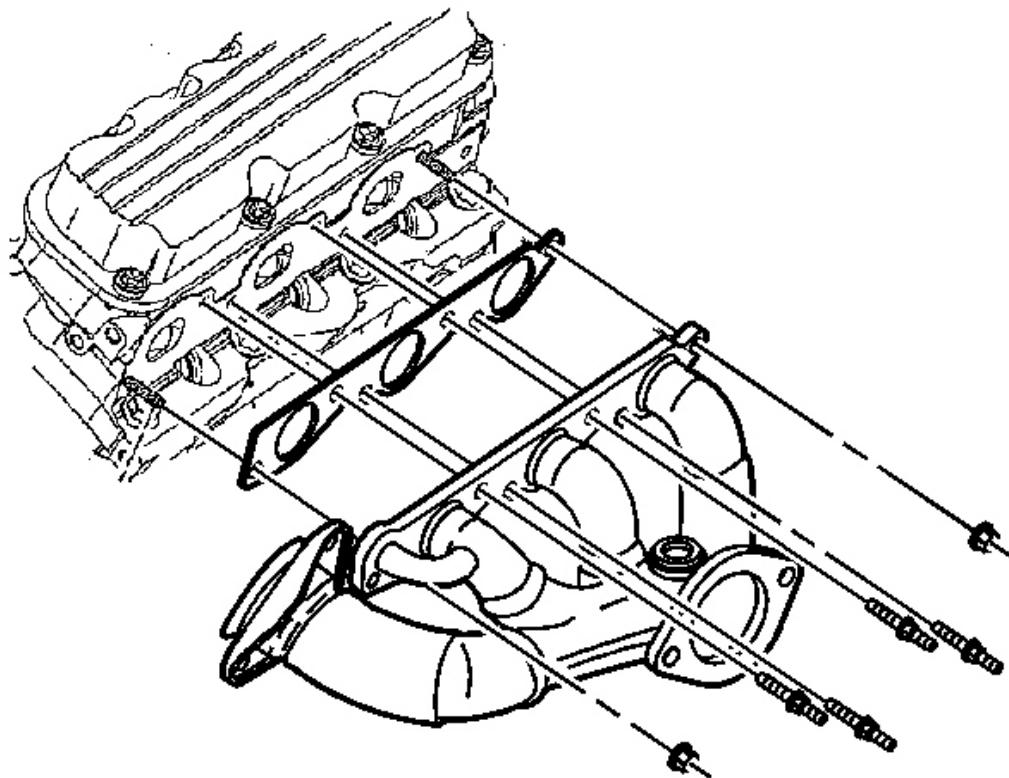
2006 Buick Lucerne CXS

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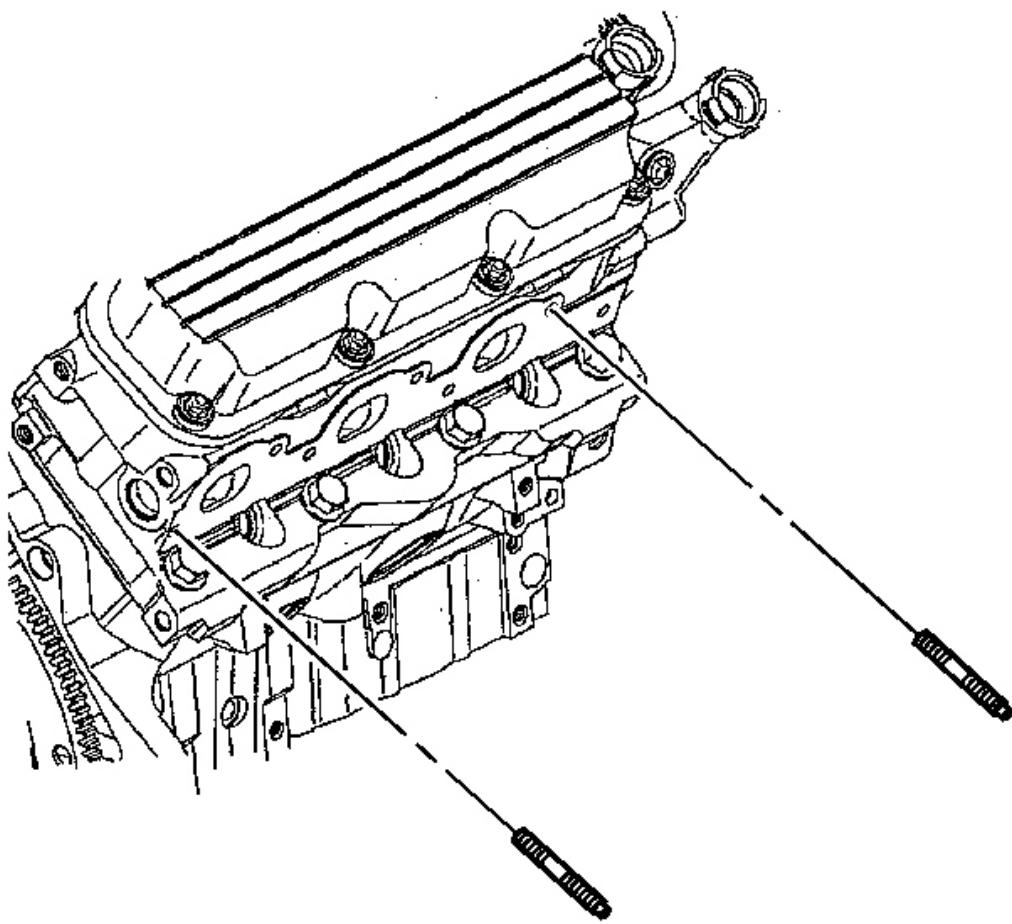
**Fig. 338: Removing/Installing Right Engine Lift Hook Bracket**  
Courtesy of GENERAL MOTORS CORP.

4. Remove the right engine lift hook nut and bolt.
5. Remove the right engine lift hook bracket.
6. Remove the right side spark plugs.



**Fig. 339: Locating Right Exhaust Manifold Components (Without A.I.R.)**  
Courtesy of GENERAL MOTORS CORP.

7. Remove the exhaust manifold studs.
8. Remove the exhaust manifold.
9. Remove the exhaust manifold gasket.

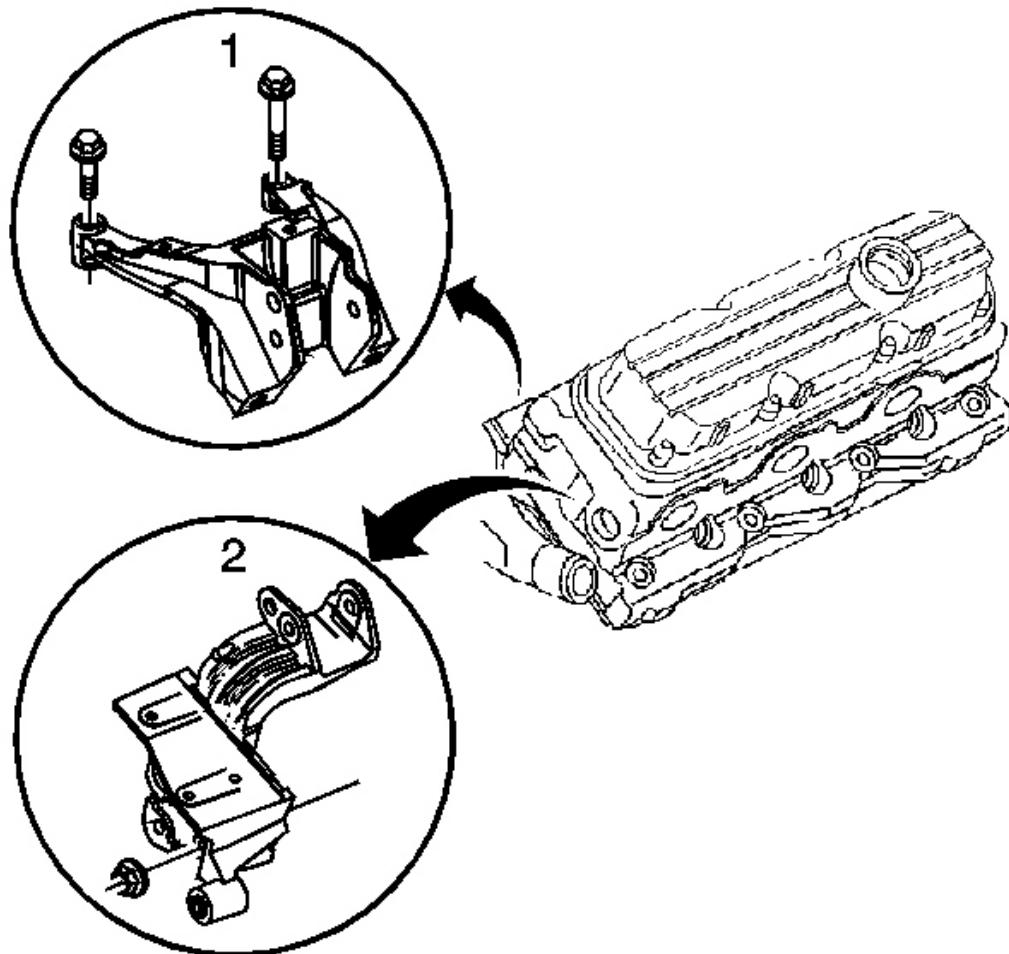


**Fig. 340: Removing/Installing Right Exhaust Manifold**  
Courtesy of GENERAL MOTORS CORP.

10. Remove the exhaust manifold studs.

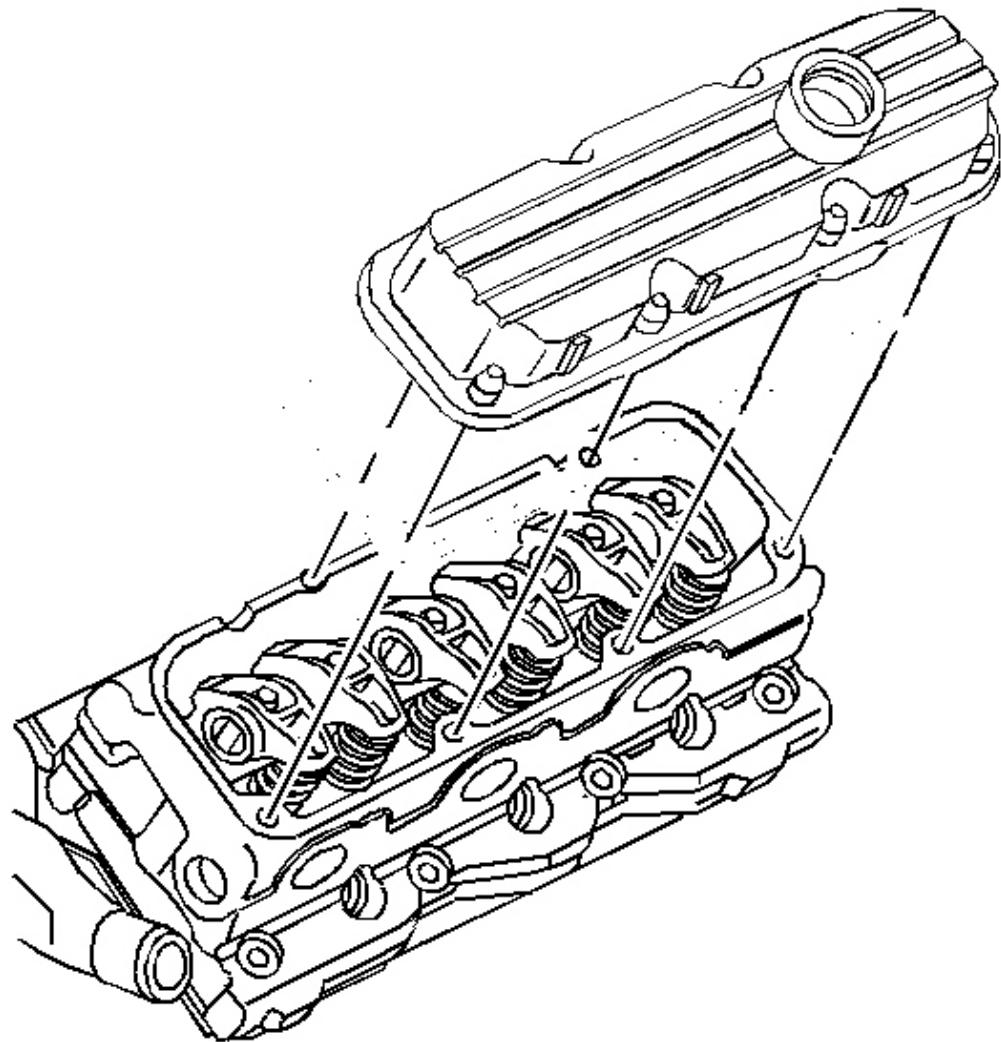
#### **VALVE ROCKER ARM COVER REMOVAL - LEFT SIDE**

##### **Removal Procedure**



**Fig. 341: View of Engine Mount Strut Upper Bracket Bolts**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine mount strut bracket nuts and bracket (2), if applicable.
2. Remove the engine mount strut upper bracket bolts and bracket (1), if applicable.

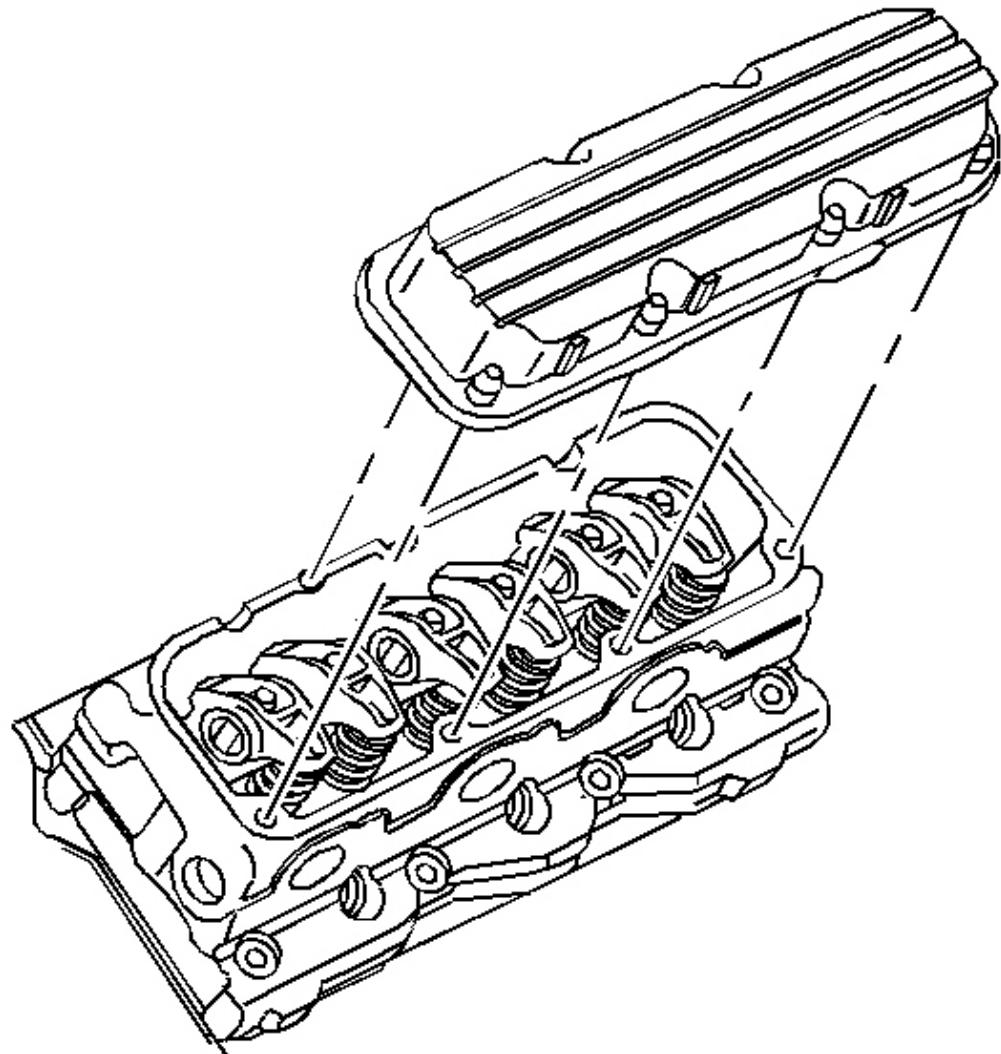


**Fig. 342: Locating Left Valve Rocker Arm Cover**  
Courtesy of GENERAL MOTORS CORP.

3. Remove the valve rocker arm cover bolts.
4. Remove the valve rocker arm cover.

#### **VALVE ROCKER ARM COVER REMOVAL - RIGHT SIDE**

##### **Removal Procedure**

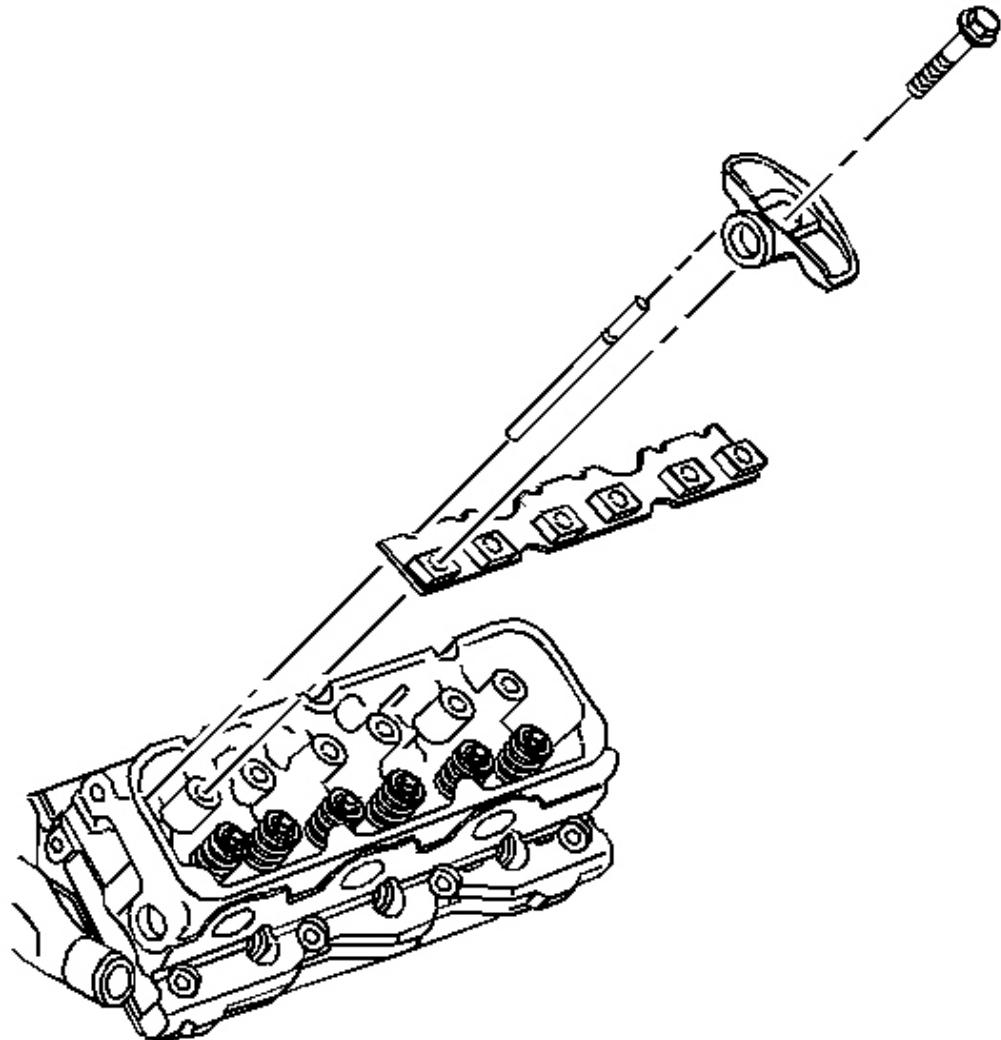


**Fig. 343: Locating Right Valve Rocker Arm Cover**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the valve rocker arm cover bolts.
2. Remove the valve rocker arm cover.

#### **VALVE ROCKER ARM AND PUSH ROD REMOVAL**

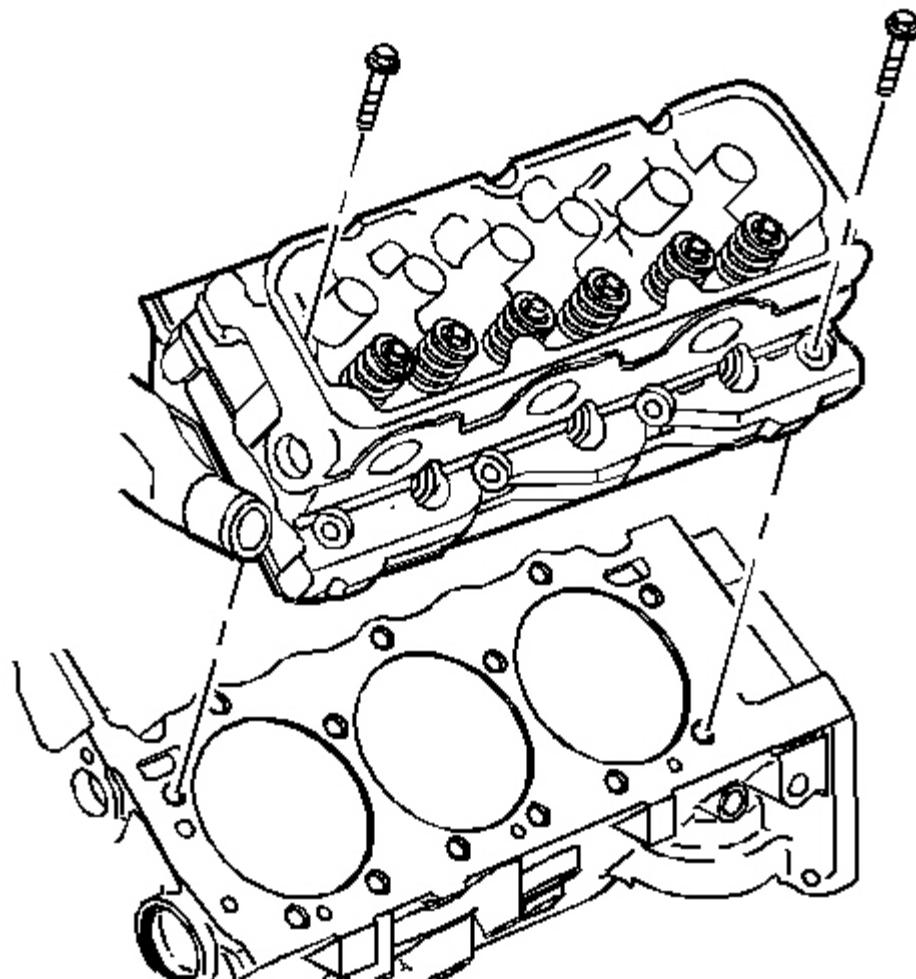
##### **Removal Procedure**



**Fig. 344: View Of Valve Rocker Arm, Bolt, Push Rod & Push Rod Guide Plate**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the valve rocker arm bolts.
2. Remove the valve rocker arm.
3. Remove the push rods.
4. Remove the push rod guide plate.

**CYLINDER HEAD REMOVAL - LEFT SIDE**



**Fig. 345: Identifying Cylinder Head & Cylinder Head Bolts**  
Courtesy of GENERAL MOTORS CORP.

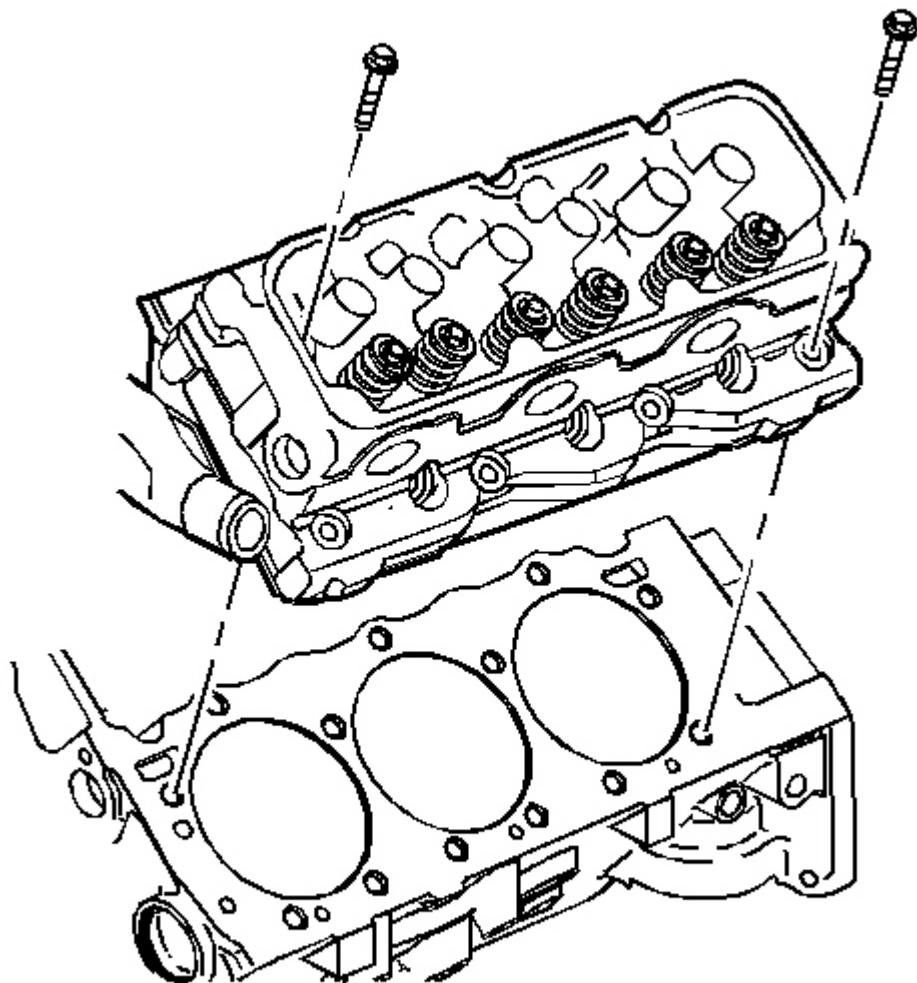
**Removal Procedure**

1. Remove the cylinder head bolts.
2. Discard the cylinder head bolts.
3. Remove the cylinder head.

4. Remove the cylinder head gasket.

#### **CYLINDER HEAD REMOVAL - RIGHT SIDE**

##### **Removal Procedure**



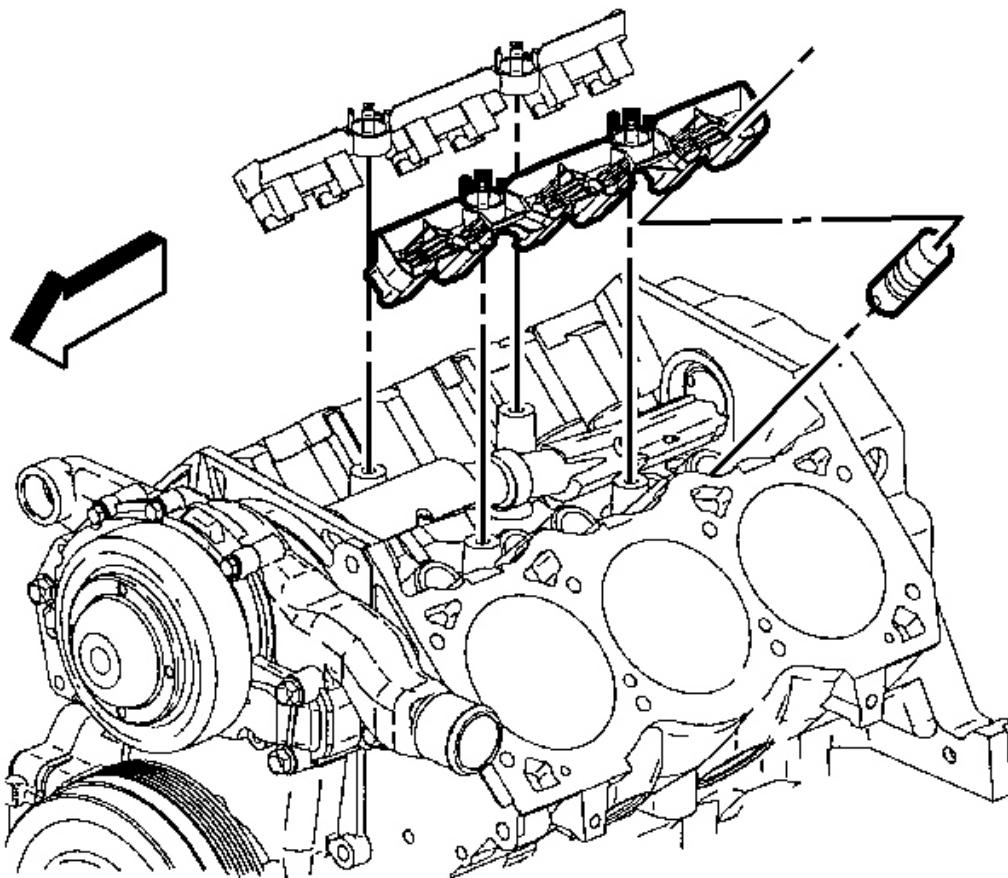
**Fig. 346: Identifying Cylinder Head & Cylinder Head Bolts**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the cylinder head bolts.

2. Discard the cylinder head bolts.
3. Remove the cylinder head.
4. Remove the cylinder head gasket.

## VALVE LIFTER REMOVAL

### Removal Procedure



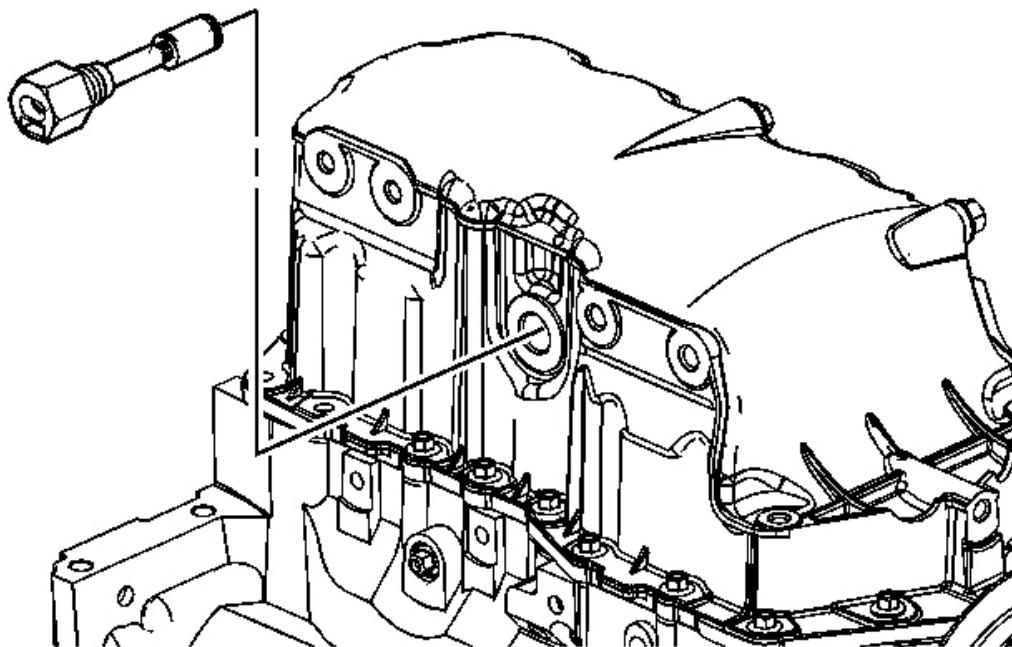
**Fig. 347: Removing/Installing Valve Lifters & Guides**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the valve lifter guide retainer bolts.
2. Remove the valve lifter guide retainers.

3. Remove the valve lifters.

## OIL PAN REMOVAL

### Removal Procedure

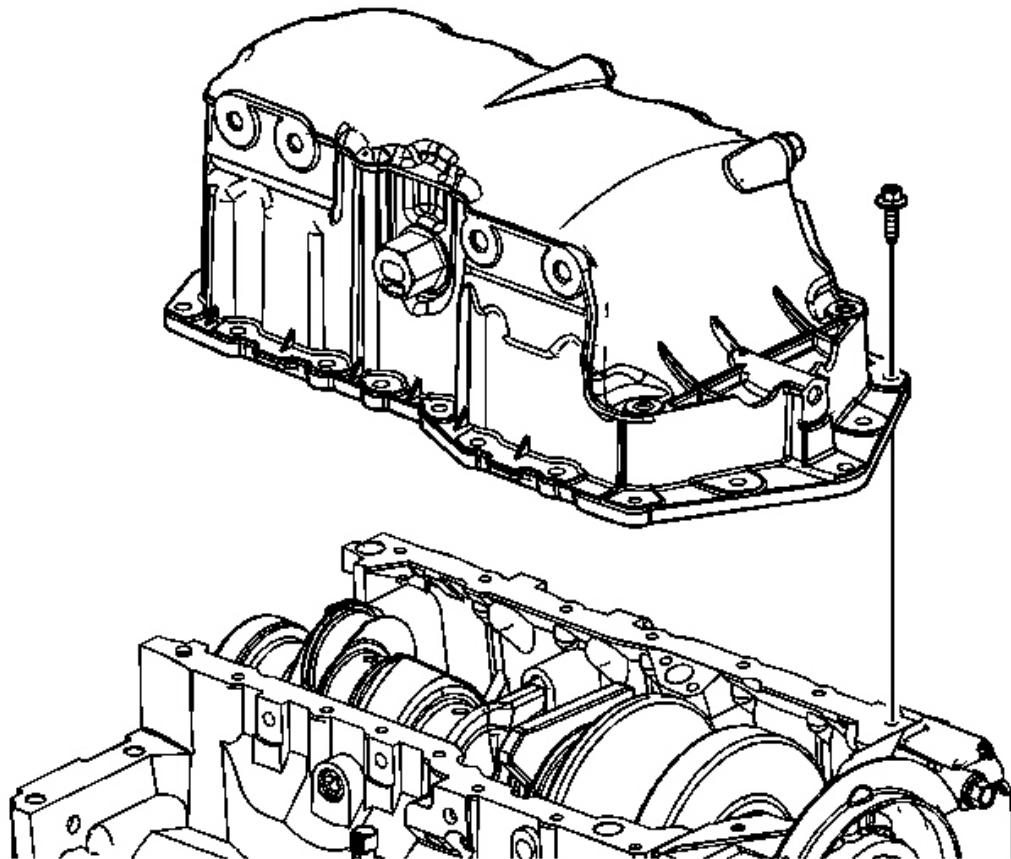


**Fig. 348: Identifying Oil Level Sensor**

Courtesy of GENERAL MOTORS CORP.

**NOTE:** Remove the oil level sensor, located in the oil pan, before the oil pan is removed. The sensor may be damaged if the oil pan is removed first.

1. Remove the oil level sensor.



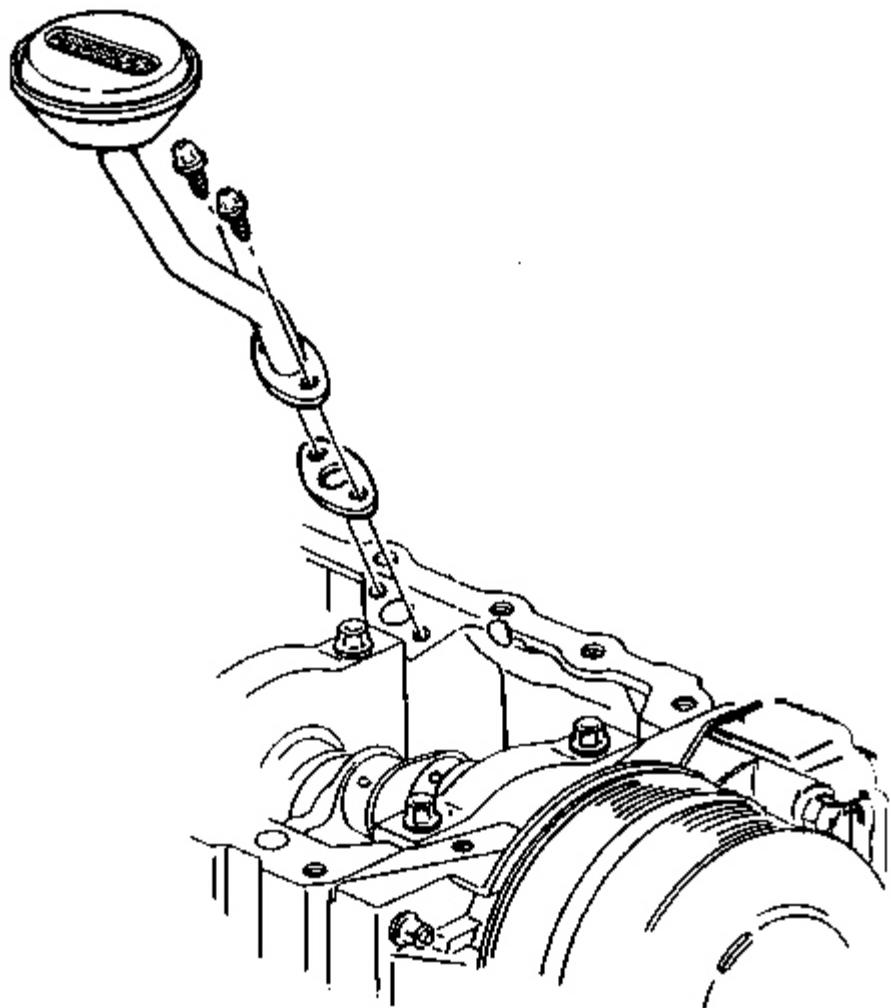
**Fig. 349: View Of Oil Pan & Bolts**

Courtesy of GENERAL MOTORS CORP.

2. Remove the oil pan bolts.
3. Remove the oil pan using pry points between the pan and engine block if required.
4. Remove the oil pan gasket if required.

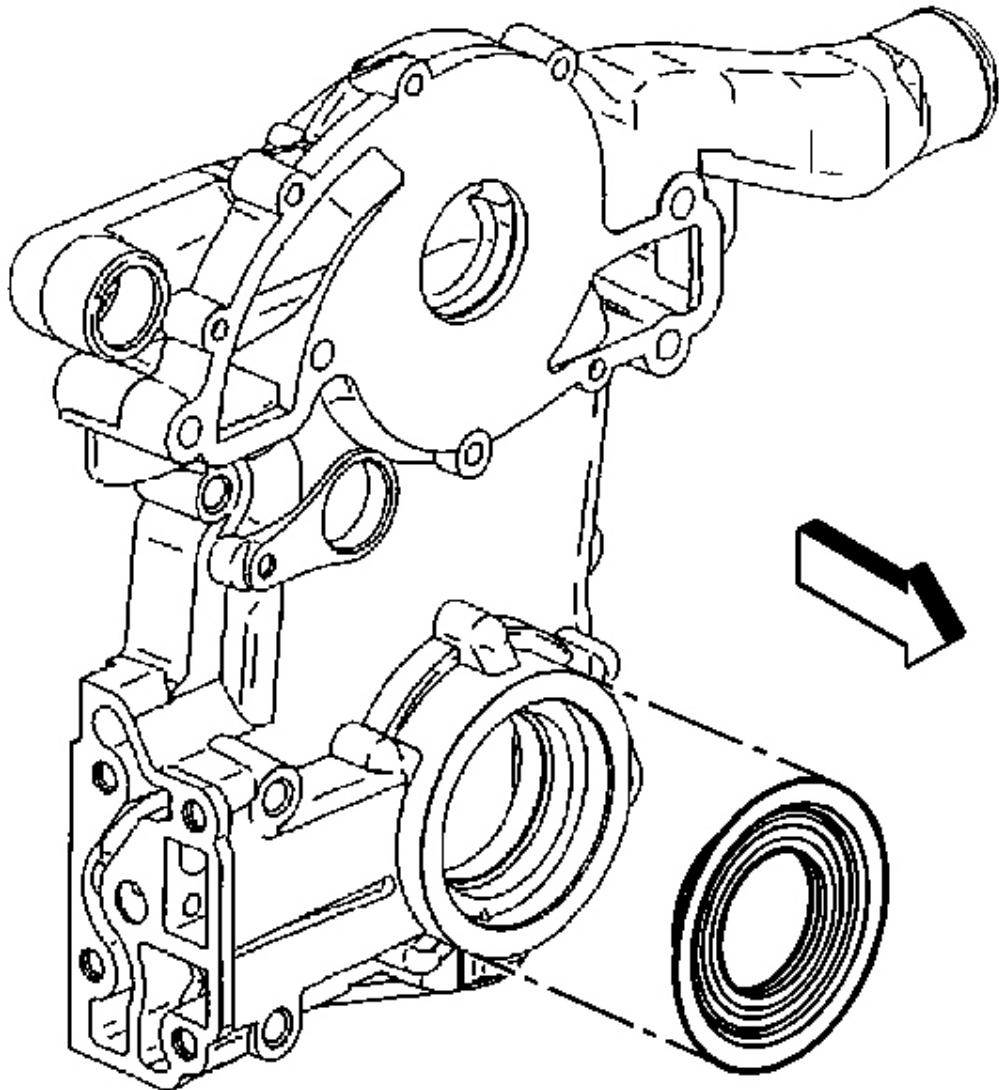
#### **OIL PUMP SUCTION PIPE AND SCREEN ASSEMBLY REMOVAL**

##### **Removal Procedure**



**Fig. 350: View Of Oil Pump Pipe & Screen Assembly**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil pump pipe and screen assembly bolts.
2. Remove the oil pump pipe and screen assembly.
3. Remove the oil pump pipe and screen assembly gasket.
4. Use solvent to clean the oil pump pipe and screen.



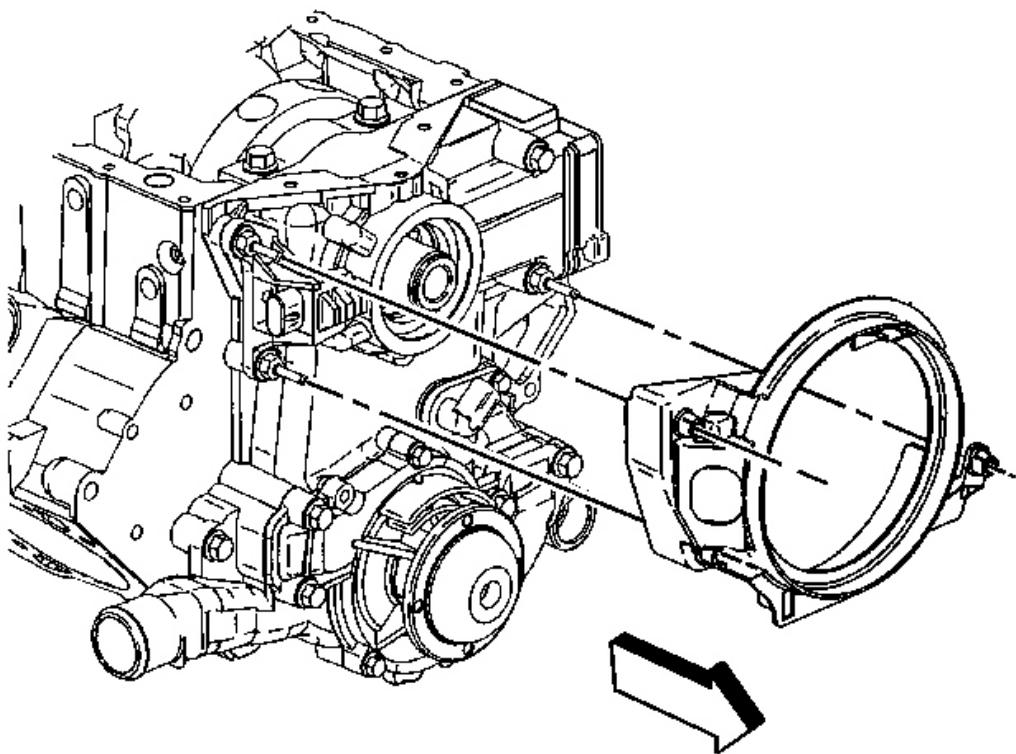
**Fig. 351: Identifying Crankshaft Front Oil Seal**

Courtesy of GENERAL MOTORS CORP.

**IMPORTANT: Do not damage the seal bore or the contact surfaces.**

Use a screwdriver to pry out the crankshaft front oil seal.

**Removal Procedure**

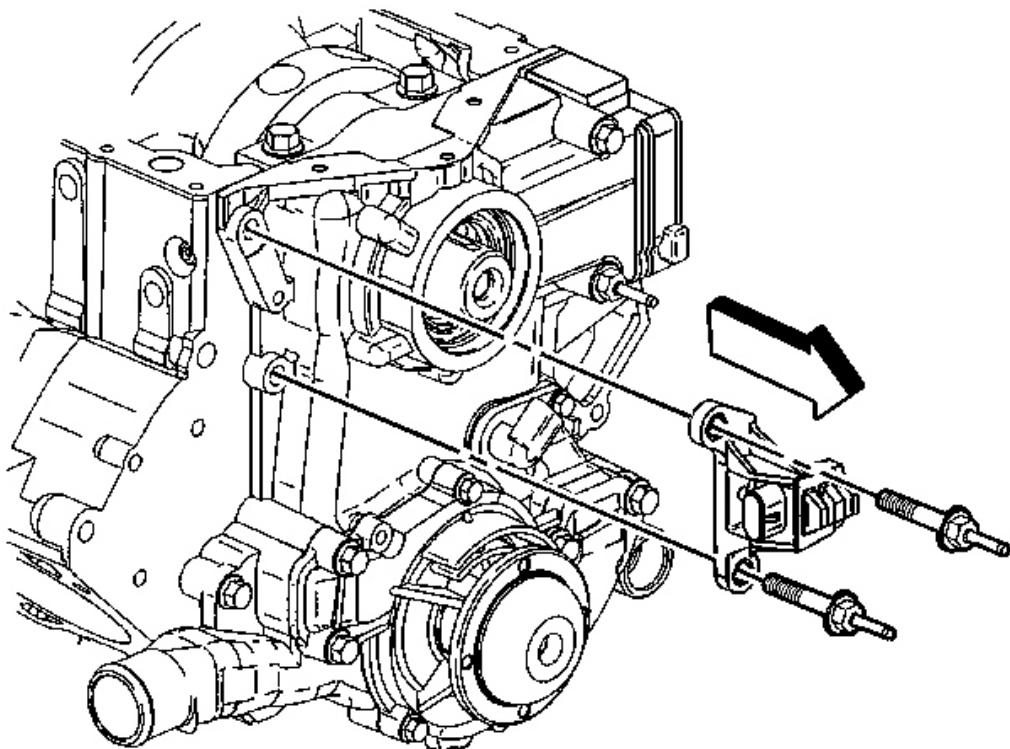


**Fig. 352: Locating Crankshaft Position Sensor Shield**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the crankshaft position sensor shield.

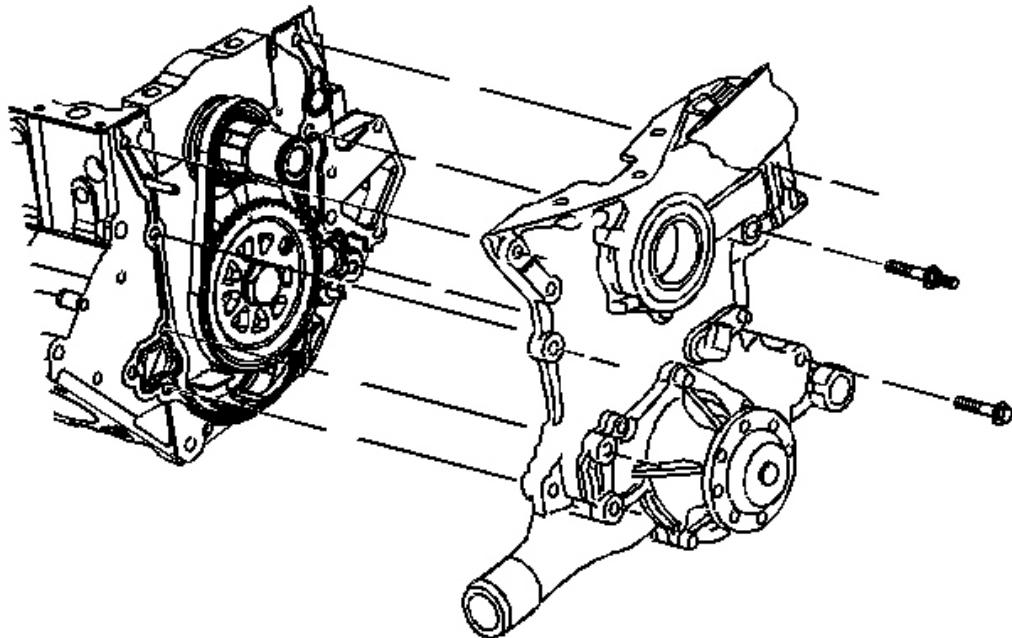
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**Fig. 353: Locating Crankshaft Position Sensor**  
Courtesy of GENERAL MOTORS CORP.

2. Remove the crankshaft position sensor studs.
3. Remove the crankshaft position sensor.

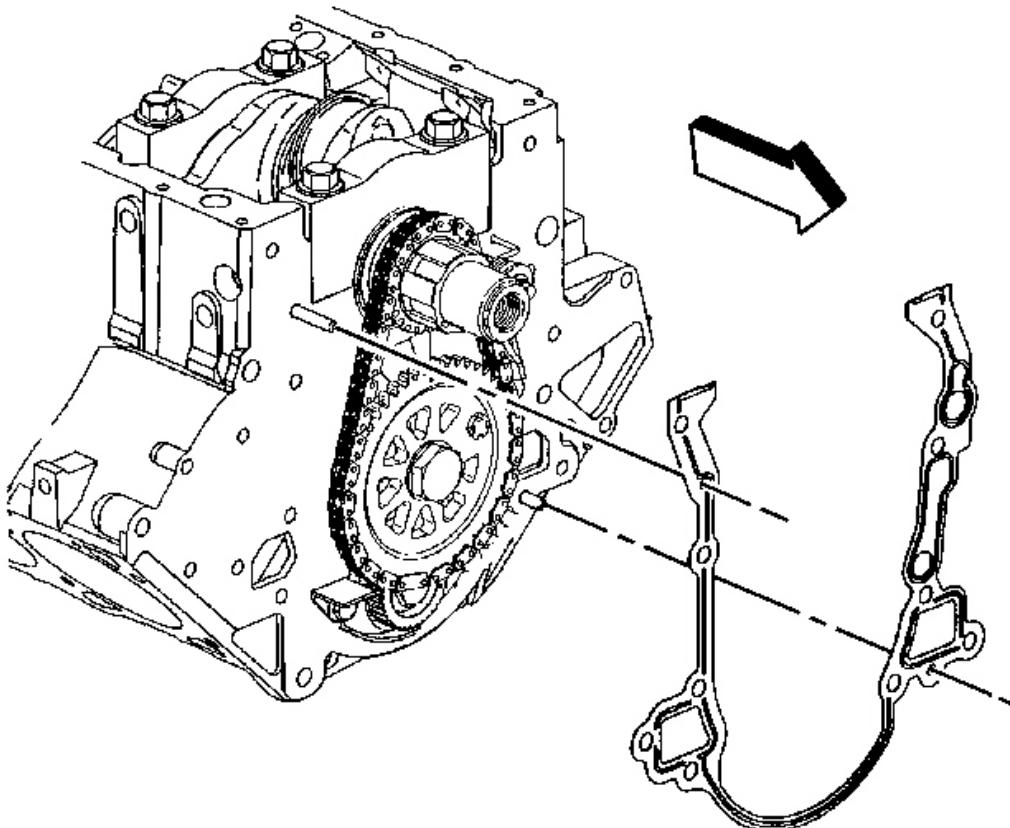


**Fig. 354: View Of Engine Front Cover**  
Courtesy of GENERAL MOTORS CORP.

4. Remove the engine front cover bolts and stud.
5. Remove the engine front cover.

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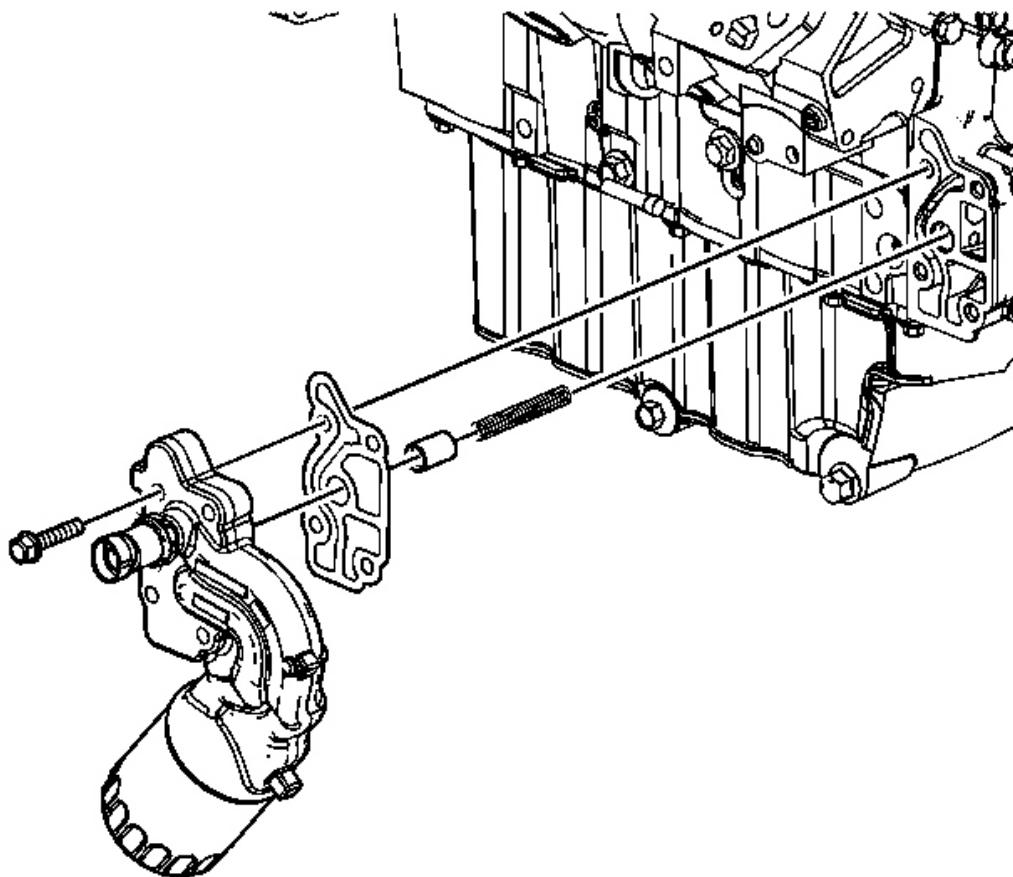


**Fig. 355: Locating Engine Front Cover Gasket**  
Courtesy of GENERAL MOTORS CORP.

6. Remove the engine front cover gasket.

### OIL FILTER ADAPTER REMOVAL

#### Removal Procedure

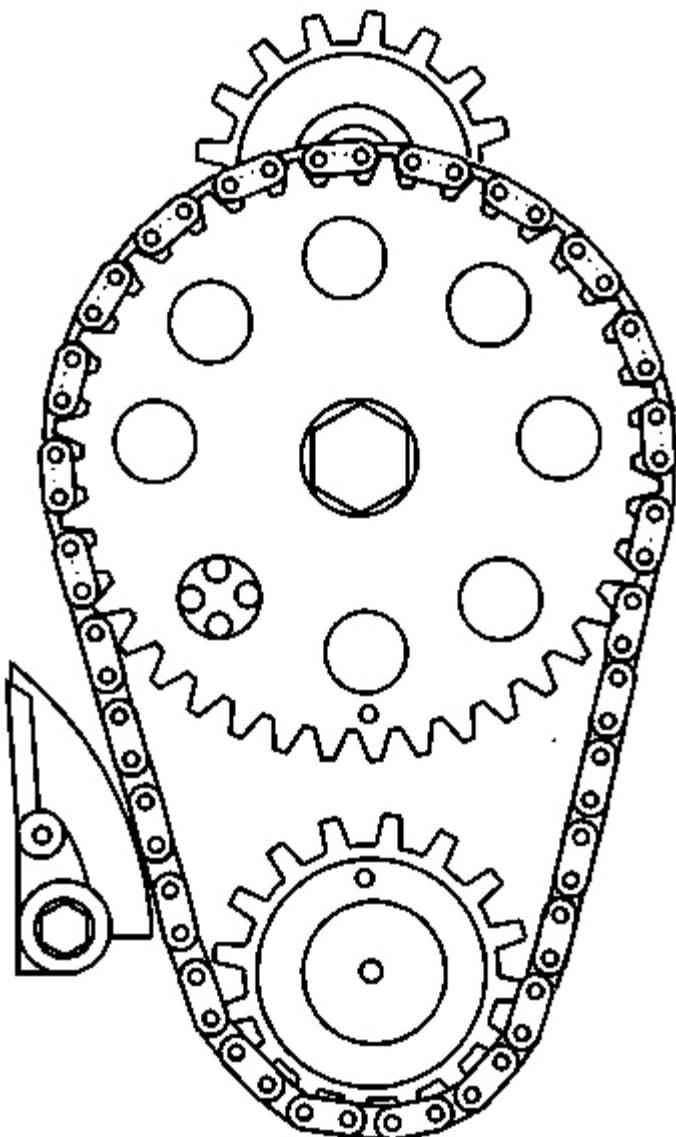


**Fig. 356: Identifying Oil Filter Adapter**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil filter adapter bolts from the engine front cover.
2. Remove the oil filter adapter.
3. Remove the oil filter adapter gasket.
4. Remove the oil pressure relief valve.
5. Remove the oil pressure relief valve spring.

## **TIMING CHAIN AND SPROCKETS REMOVAL**

### **Removal Procedure**

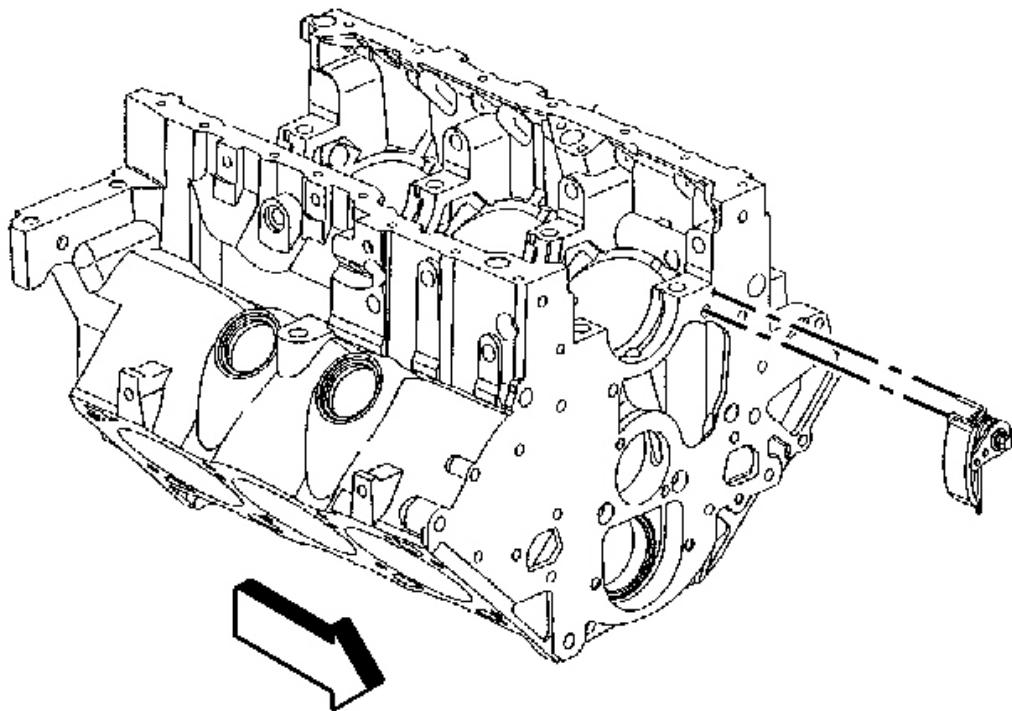


**Fig. 357: Aligning Timing Chain & Sprocket Timing Marks**  
Courtesy of GENERAL MOTORS CORP.

1. Align the timing marks on the sprockets.

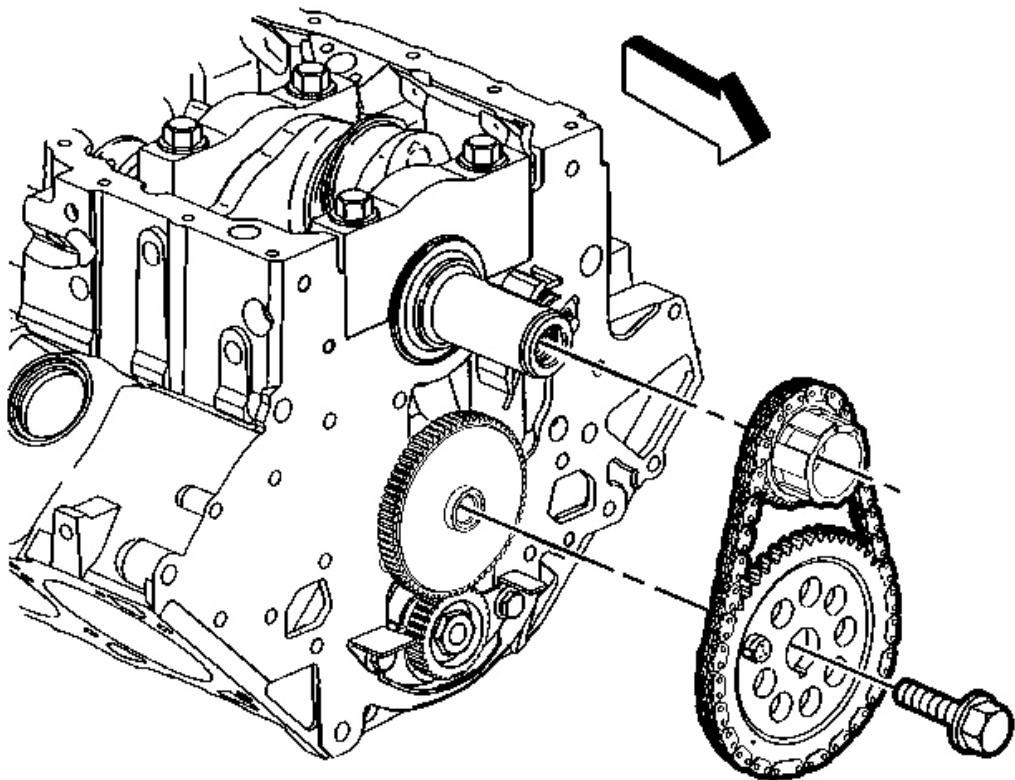
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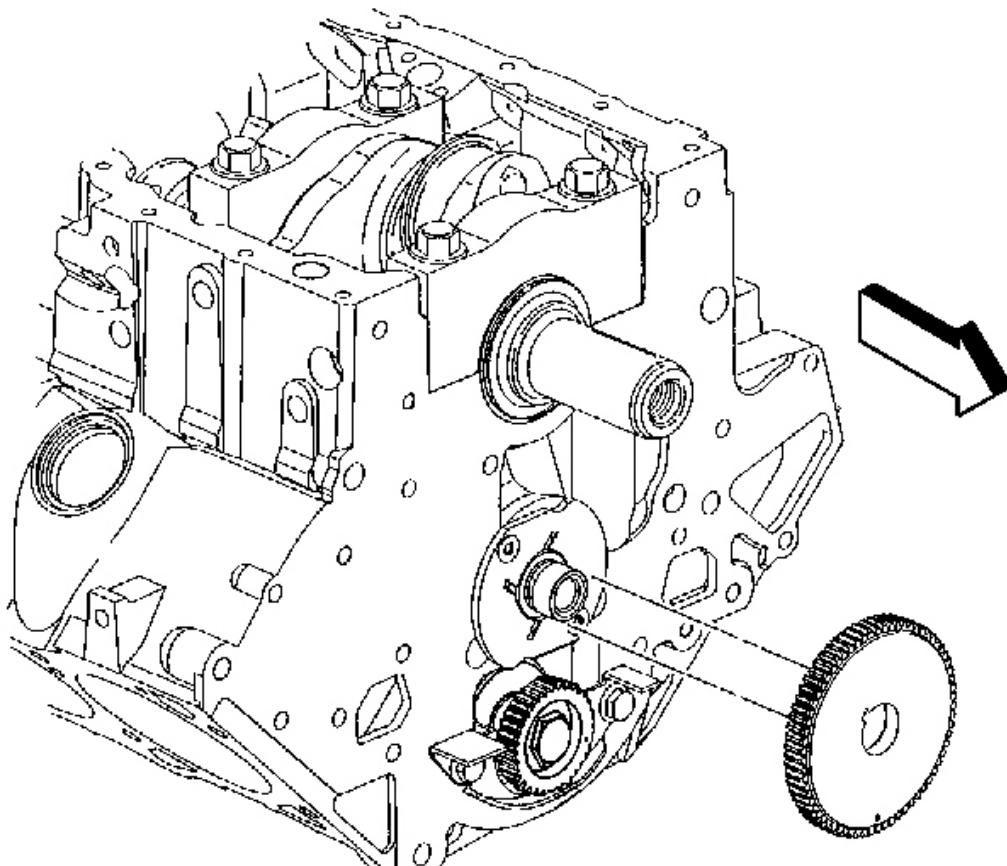
**Fig. 358: View Of Timing Chain Dampener**  
Courtesy of GENERAL MOTORS CORP.

2. Remove the timing chain dampener.



**Fig. 359: Timing Chain, Crankshaft Sprocket & Camshaft Sprocket (L26)**  
Courtesy of GENERAL MOTORS CORP.

3. Remove the camshaft sprocket bolt.
4. Remove the camshaft sprocket.
5. Remove the timing chain.
6. Remove the crankshaft sprocket.
7. Remove the crankshaft balancer key.



**Fig. 360: Balance Shaft Drive Gear**

Courtesy of GENERAL MOTORS CORP.

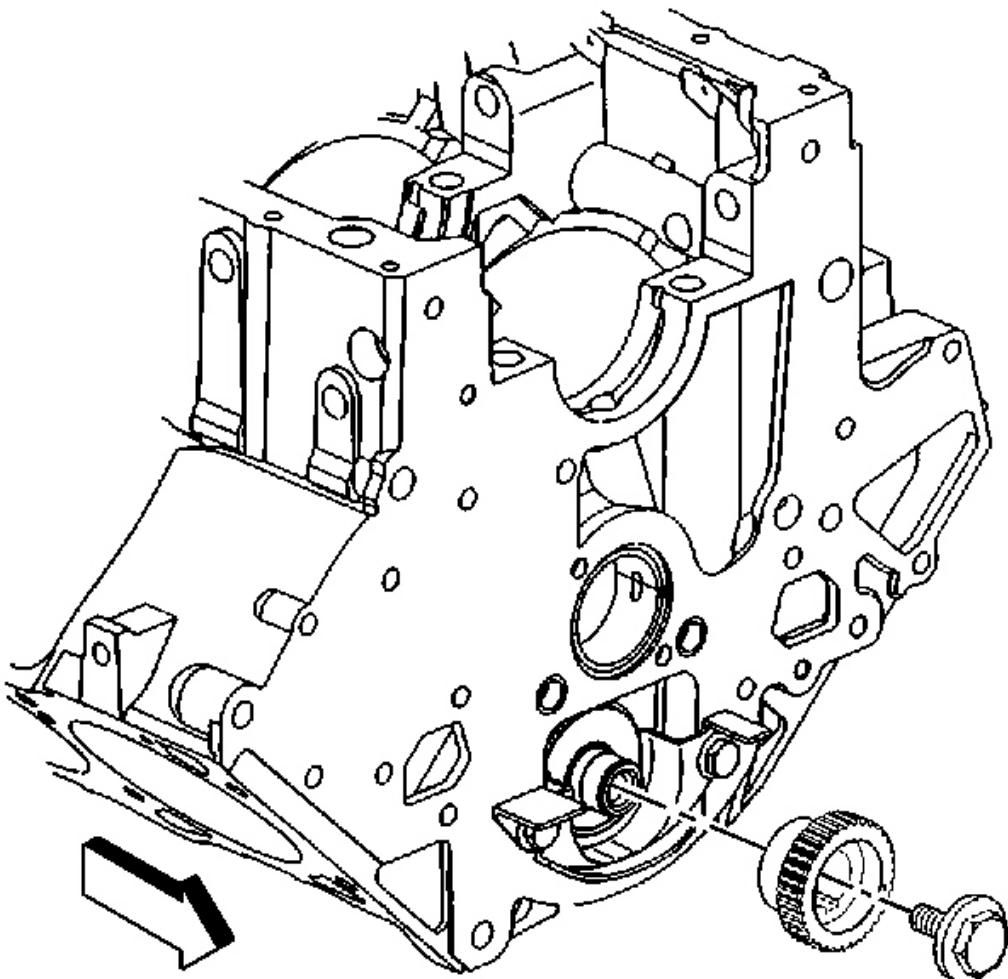
8. Remove the balance shaft drive gear.

#### **BALANCE SHAFT REMOVAL**

##### **Tools Required**

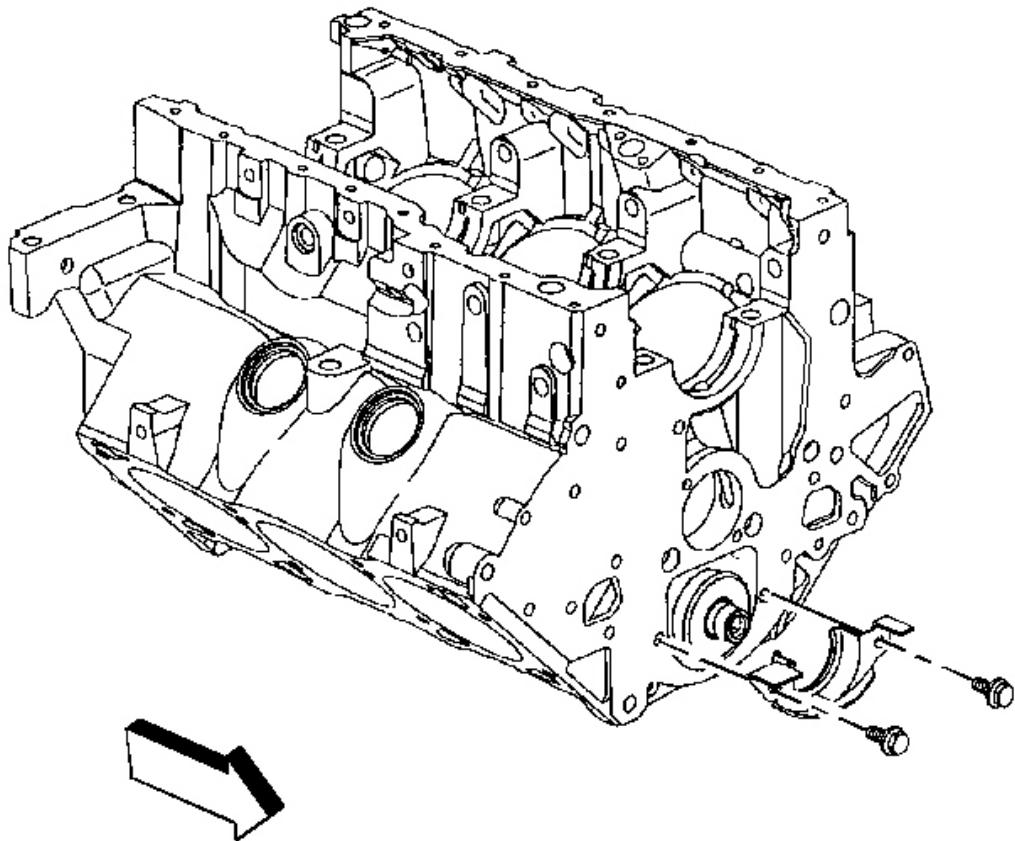
**J 6125-1B** Slide Hammer. See **Special Tools**.

##### **Removal Procedure**



**Fig. 361: Locating Balance Shaft Driven Gear & Bolt**  
Courtesy of GENERAL MOTORS CORP.

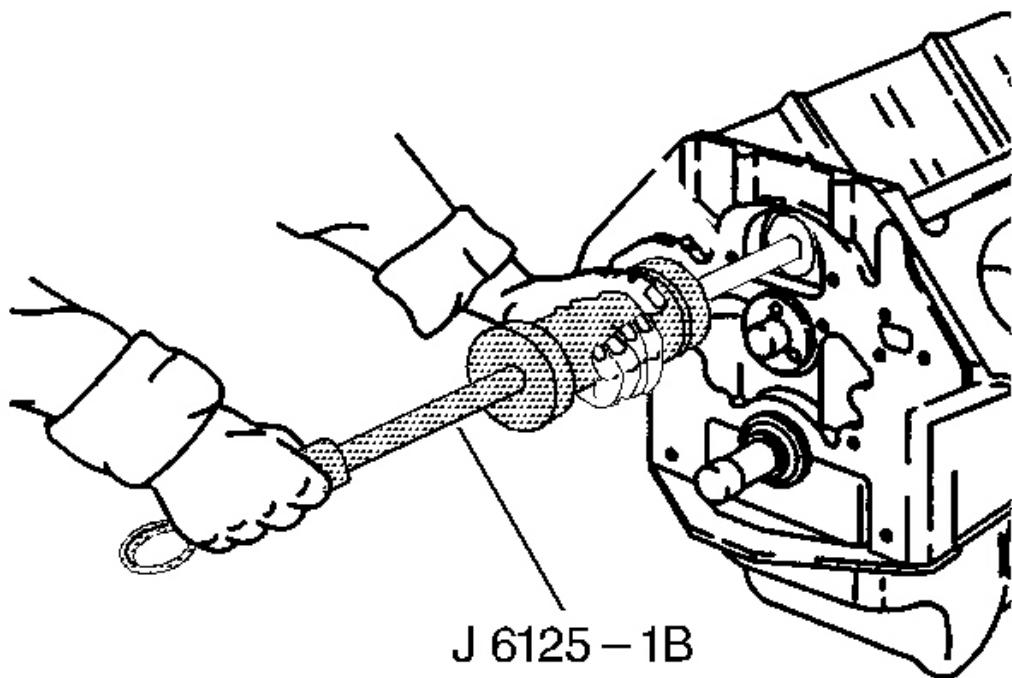
1. Remove the balance shaft driven gear bolt.
2. Remove the balance shaft driven gear.



**Fig. 362: View Of Balance Shaft Retainer**

Courtesy of GENERAL MOTORS CORP.

3. Remove the balance shaft retainer bolts.
4. Remove the balance shaft retainer.



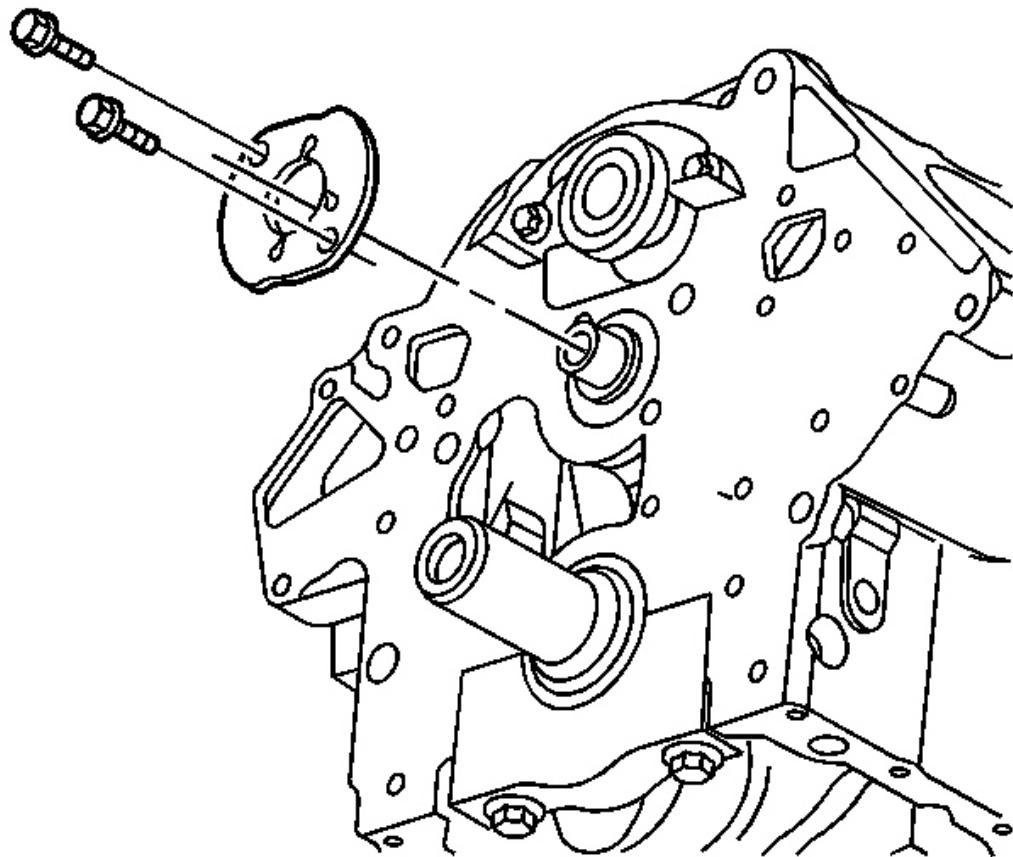
**Fig. 363: Removing Balance Shaft**

Courtesy of GENERAL MOTORS CORP.

5. Use **J 6125-1B** to remove the balance shaft. See Special Tools.

## CAMSHAFT REMOVAL

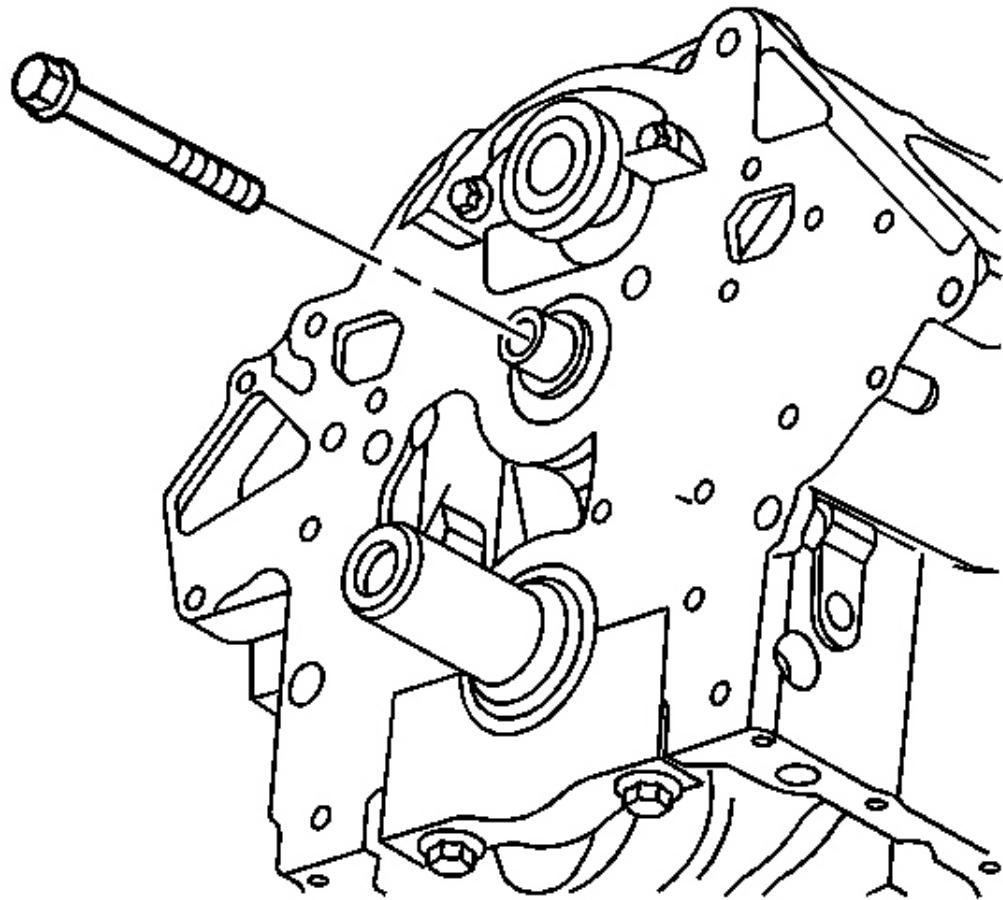
### Removal Procedure



**Fig. 364: Identifying Camshaft Thrust Plate & Screws**

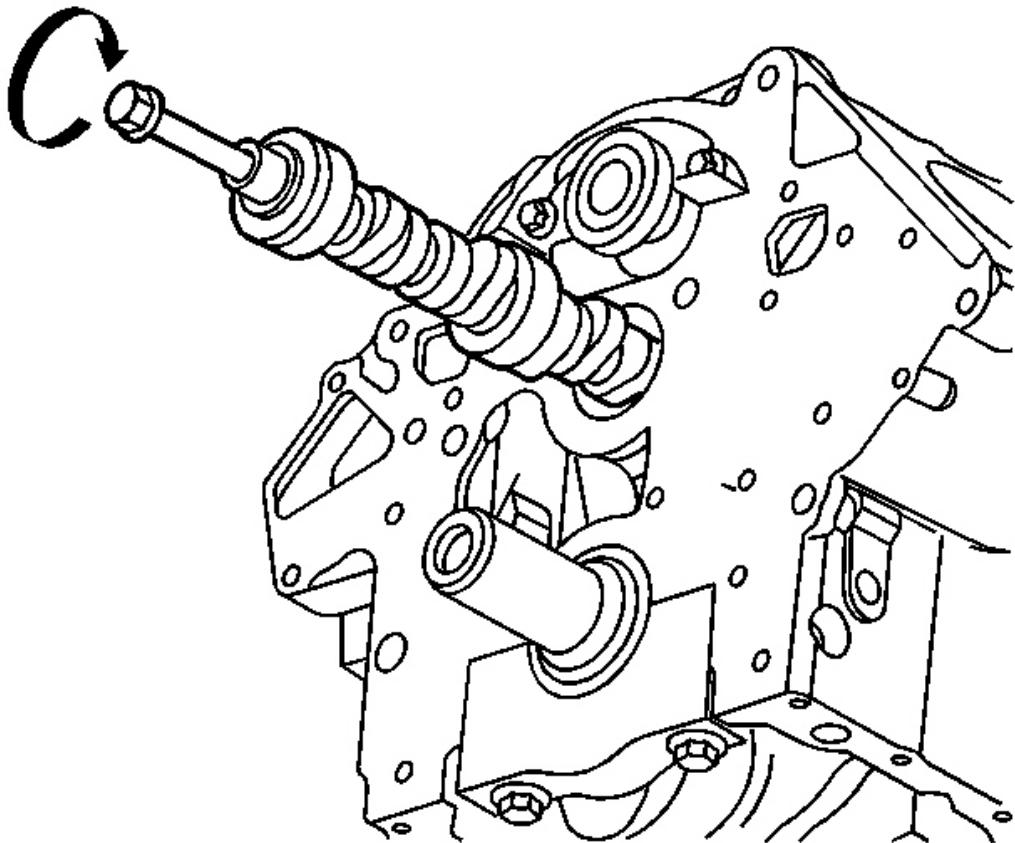
Courtesy of GENERAL MOTORS CORP.

1. Remove the camshaft thrust plate screws.
2. Remove the camshaft thrust plate.



**Fig. 365: View of Camshaft Front Bolt**  
Courtesy of GENERAL MOTORS CORP.

3. Install one 1/2-20 x 6.0 inch bolt in the camshaft front bolt hole.



**Fig. 366: Rotating & Pulling Camshaft Out Of Bearings**

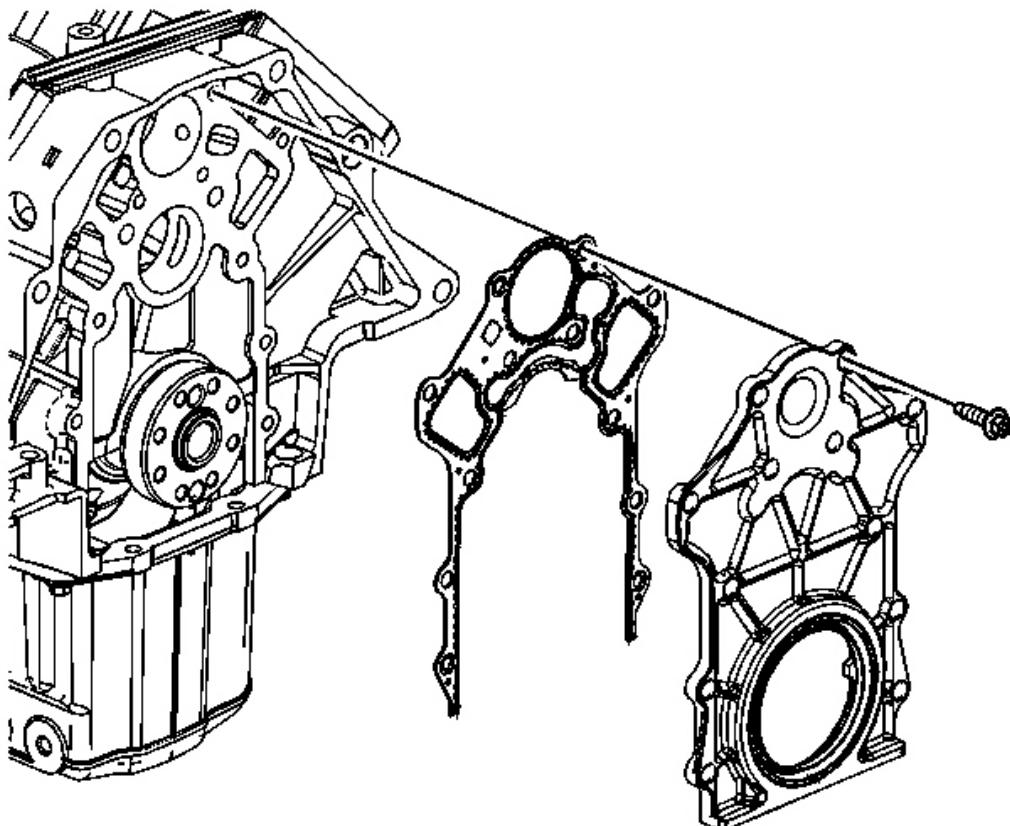
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT: All camshaft journals are the same diameter, so care must be used in removing the camshaft to avoid damage to the bearings.**

4. Carefully rotate and pull the camshaft out of the bearings.

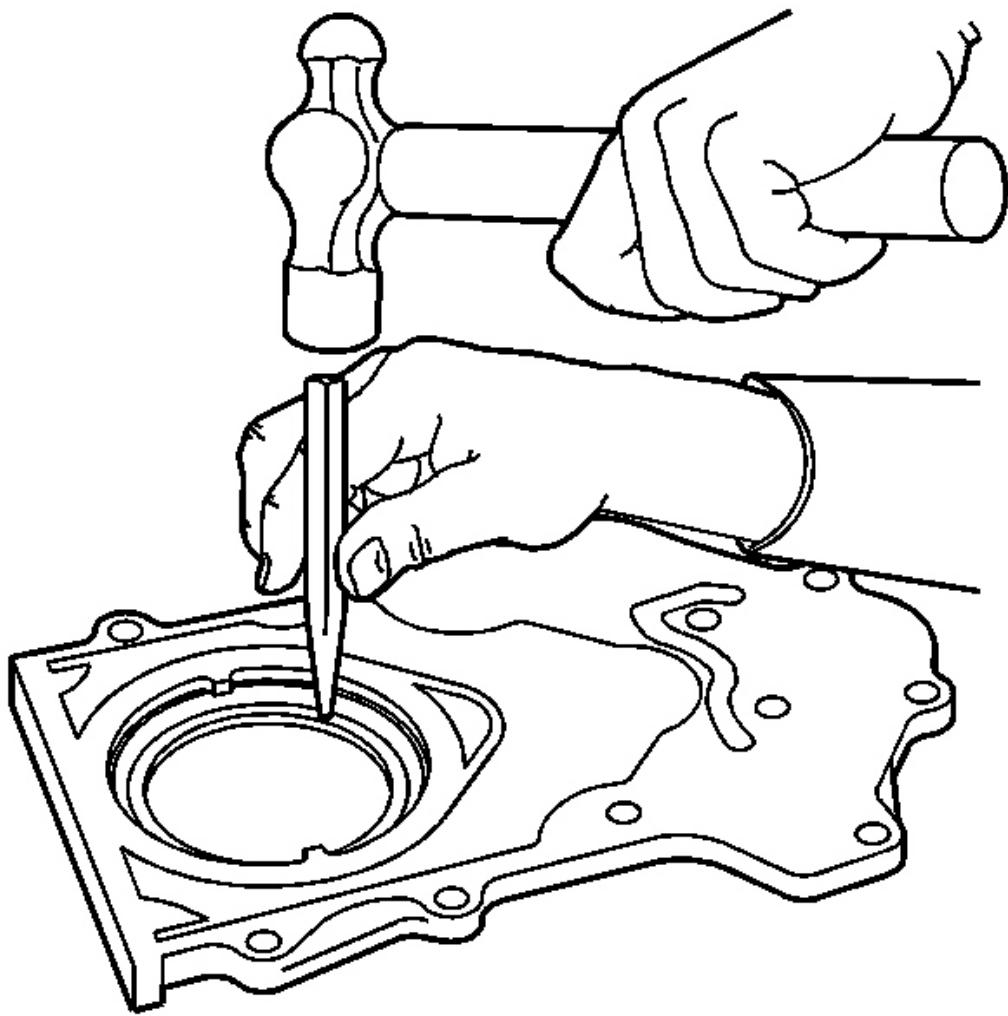
#### CRANKSHAFT REAR OIL SEAL AND HOUSING REMOVAL (SECOND DESIGN)

##### Removal Procedure



**Fig. 367: Crankshaft Rear Oil Seal & Housing (Second Design)**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the crankshaft rear oil seal housing bolts.
2. Remove the crankshaft rear oil seal housing and gasket.

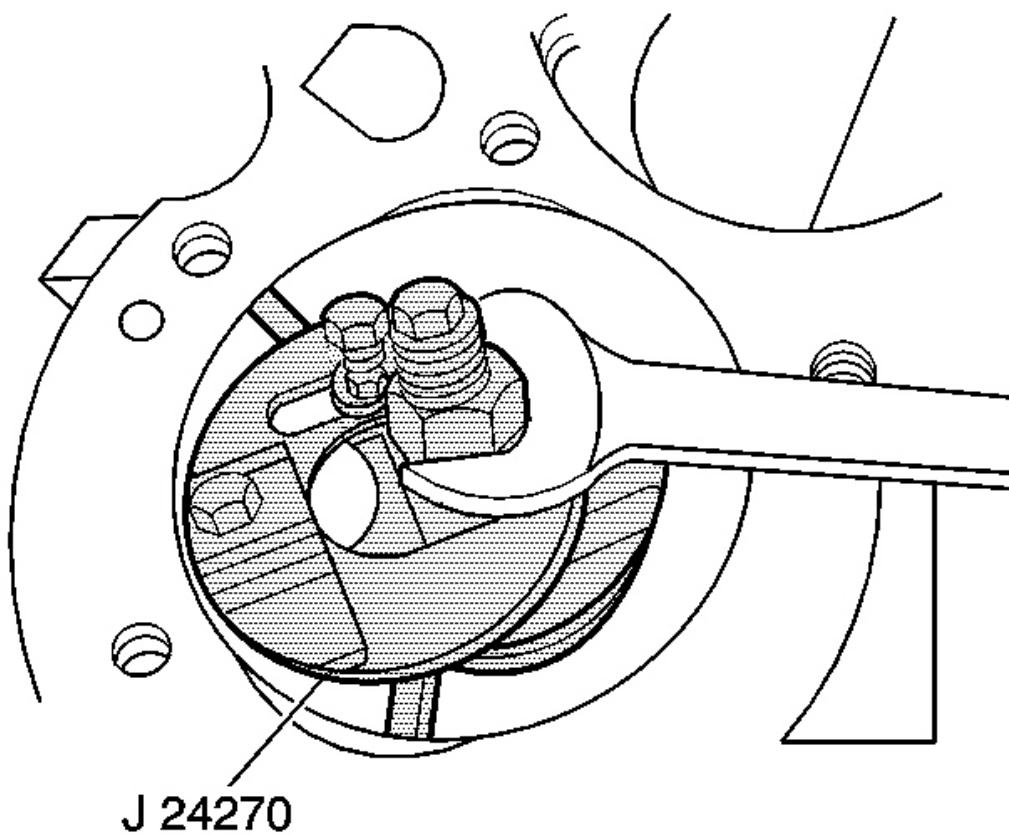


**Fig. 368: Locating Crankshaft Rear Oil Seal In Housing**  
Courtesy of GENERAL MOTORS CORP.

3. Place the crankshaft rear oil seal housing face down on a clean surface and support with blocks of wood.
4. Use a suitable driving tool and hammer and lightly tap around the outer edge of the seal to remove it.

**Tools Required**

- **J 41507** Connecting Rod Guide Assembly. See [Special Tools](#).
- **J 24270** Cylinder Ridge Reamer. See [Special Tools](#).

**Removal Procedure****Fig. 369: Removing Cylinder Bore Ring Ridge**

Courtesy of GENERAL MOTORS CORP.

1. Mark the connecting rod cap and the connecting rod for proper installation.

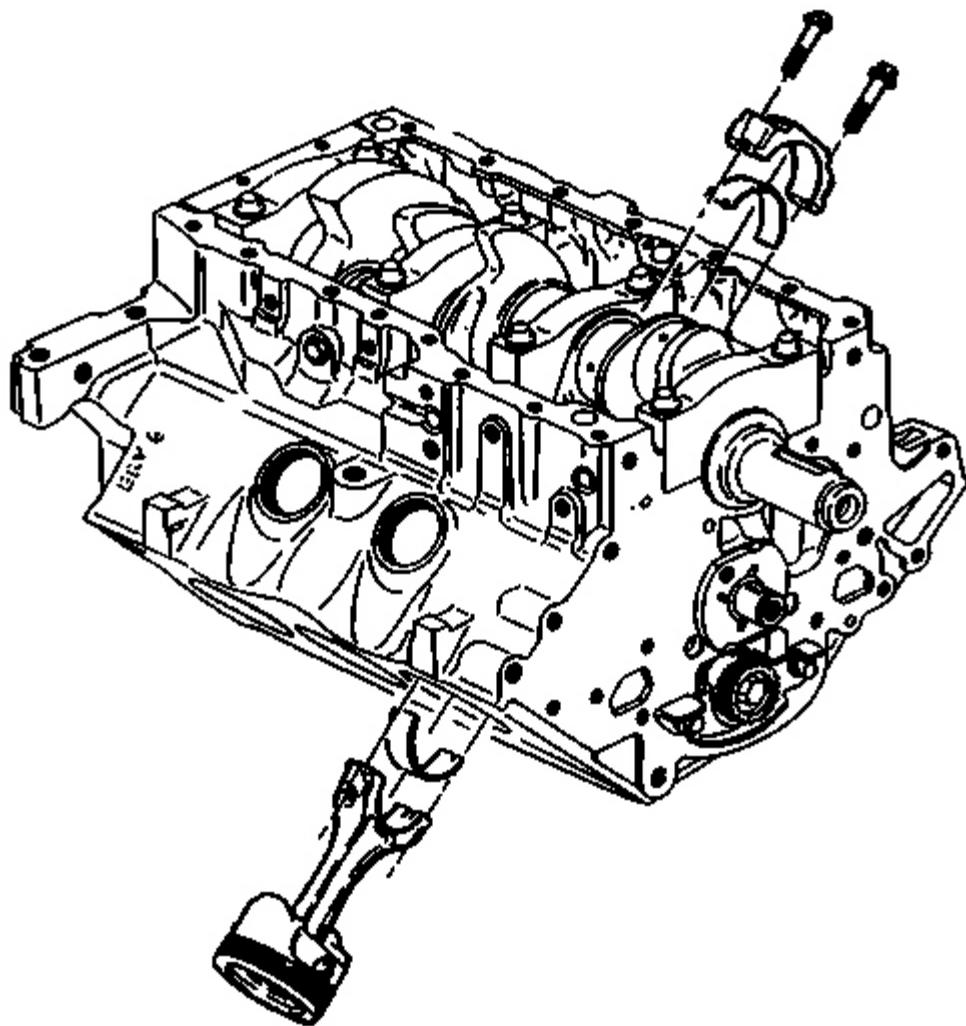
**NOTE:** If there is a pronounced ridge at the top of the piston travel, the ridge must be removed with a ridge reamer before the piston and connecting rod assembly are removed. Applying force may

**break the piston rings or damage the piston.**

2. Use the **J 24270** to remove the cylinder bore ring ridge. See [Special Tools](#).
  1. Turn the crankshaft until the piston is at the bottom of the stroke.
  2. Cover the piston with a cloth.
  3. Remove the cylinder ring ridge.
  4. Turn the crankshaft until the piston is at the top of the stroke.
  5. Remove the cloth.
  6. Remove the metal shavings from the cylinder and piston.

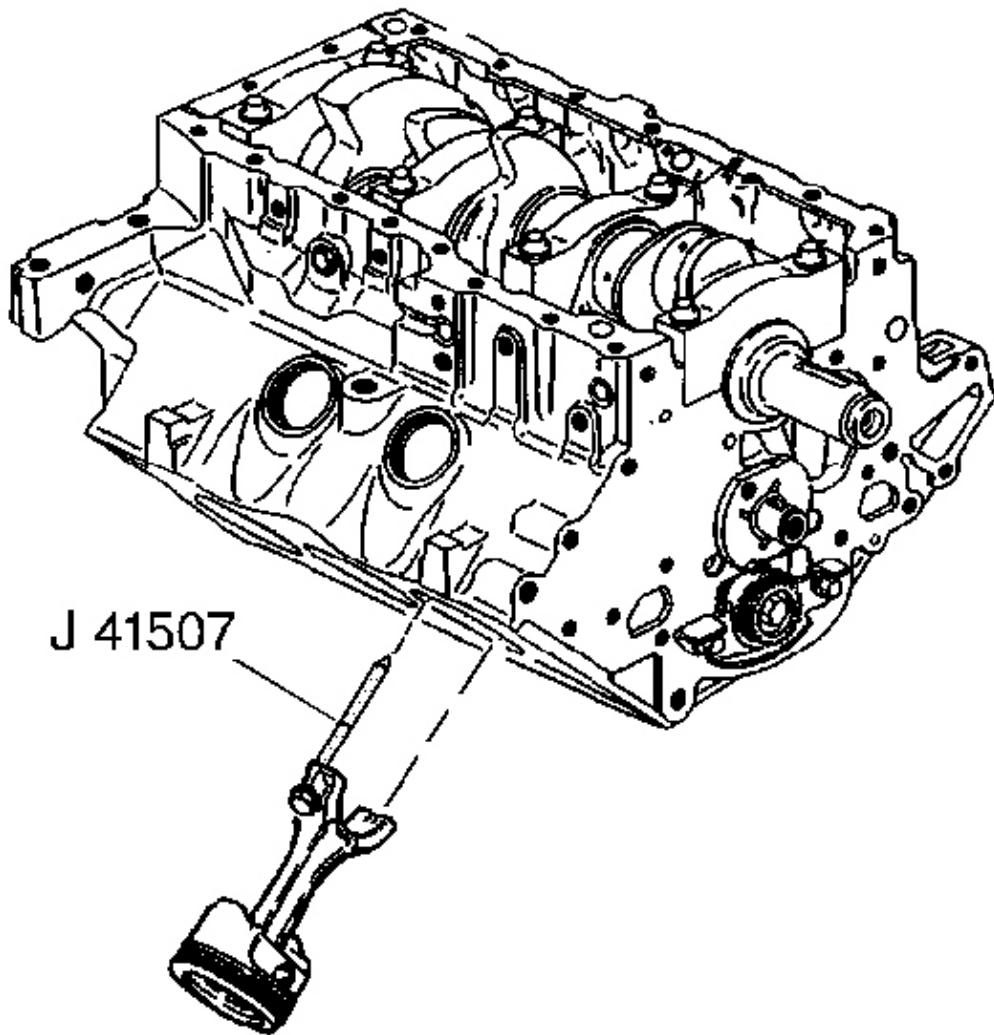
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**Fig. 370: Identifying Connecting Rod Bolts & Cap**  
Courtesy of GENERAL MOTORS CORP.

3. Remove the connecting rod bolts.
4. Remove the connecting rod cap.



**Fig. 371: Installing J 41507 To Connecting Rod**

Courtesy of GENERAL MOTORS CORP.

5. Install **J 41507** to the connecting rod. See **Special Tools**. Hand tighten the tool to the connecting rod.
6. Use hand pressure on **J 41507** to push the connecting rod towards the top of the cylinder. See **Special Tools**.

**IMPORTANT: Mark the piston with the number of the cylinder from which it was removed. Mark the piston as to what is the front for proper reassembly.**

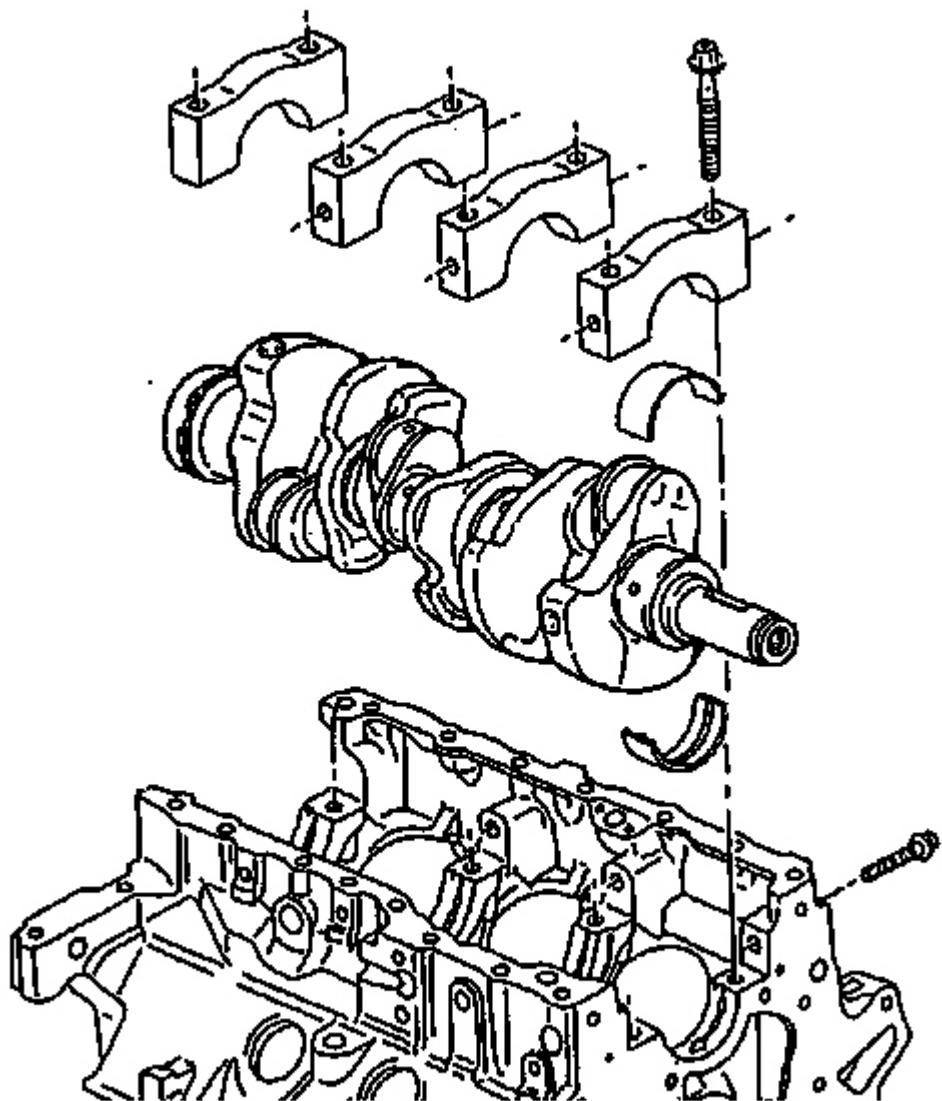
7. Remove the piston, the connecting rod and the connecting rod bearings.

## CRANKSHAFT AND BEARING REMOVAL

### Tools Required

- **J 6125-1B** Slide Hammer. See [Special Tools](#).
- **J 41348** Main Bearing Cap Puller. See [Special Tools](#).

### Removal Procedure

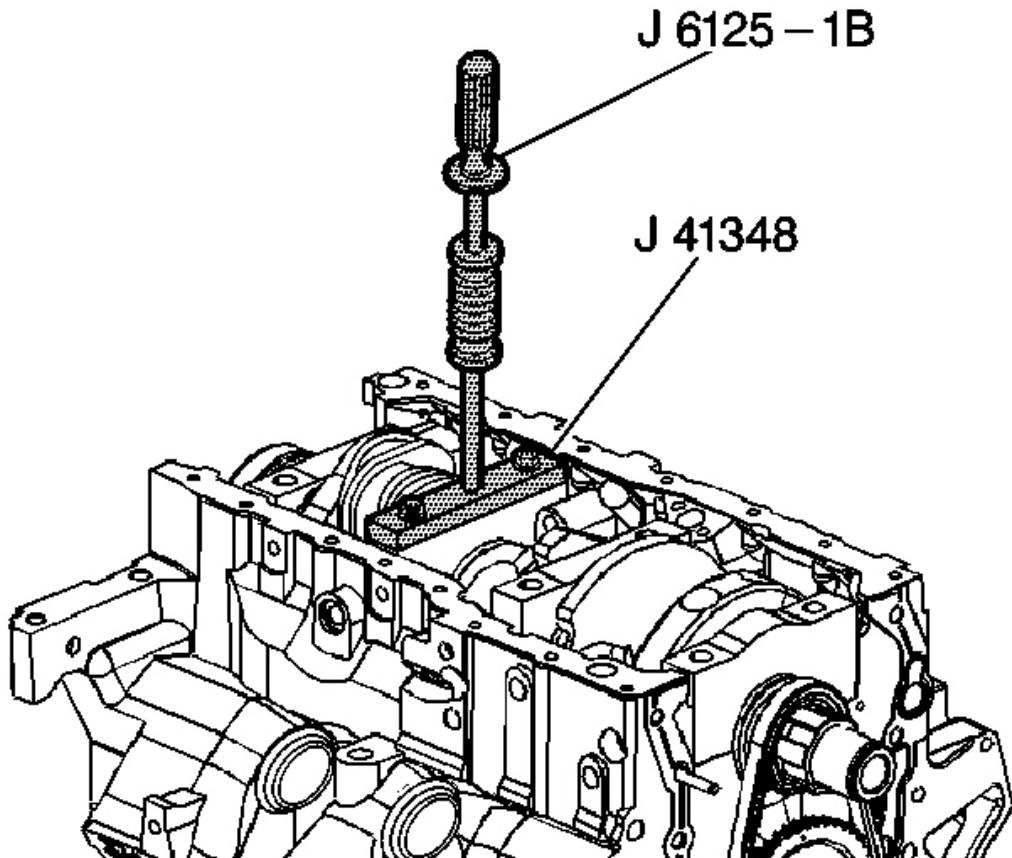


**Fig. 372: View Of Crankshaft, Bearings And Bearing Caps**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT: This engine has side bolts on all of the main caps except the rear cap. These bolts must be removed to service the caps.**

1. Remove the crankshaft main bearing cap side bolts.

2. Remove the crankshaft main bearing cap bolts.



**Fig. 373: Removing Main Bearing Caps**

Courtesy of GENERAL MOTORS CORP.

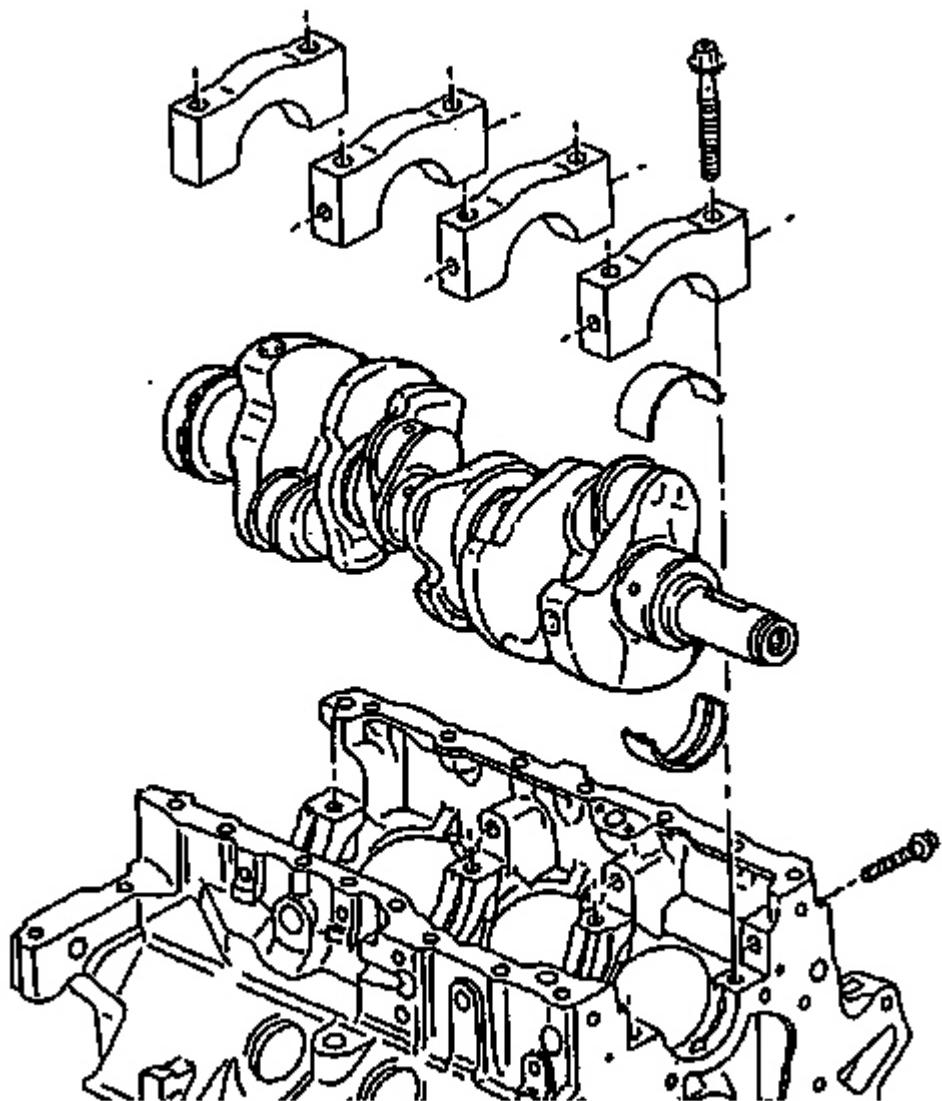
**NOTE:** Main bearing caps are press fit. Remove the caps carefully for service. J 41348 has been designed to work with J 6125-B in order to prevent damage to the bearing and cap. J 41348 MUST be installed properly into the bolt holes of the caps and J 6125-B attached to J 41348 in order to properly remove the main cap without damaging the bearing or the cap. Any deviation from this procedure may cause damage to the cap and the bearing and may result in future engine damage.

**NOTE:** Refer to Fastener Notice .\

3. Install **J 41348** into the crankshaft main bearing cap bolt holes. See Special Tools.

**Tighten:** Tighten the bolts on **J 41348** to 12 N. See Special Tools.m (100 lb in).

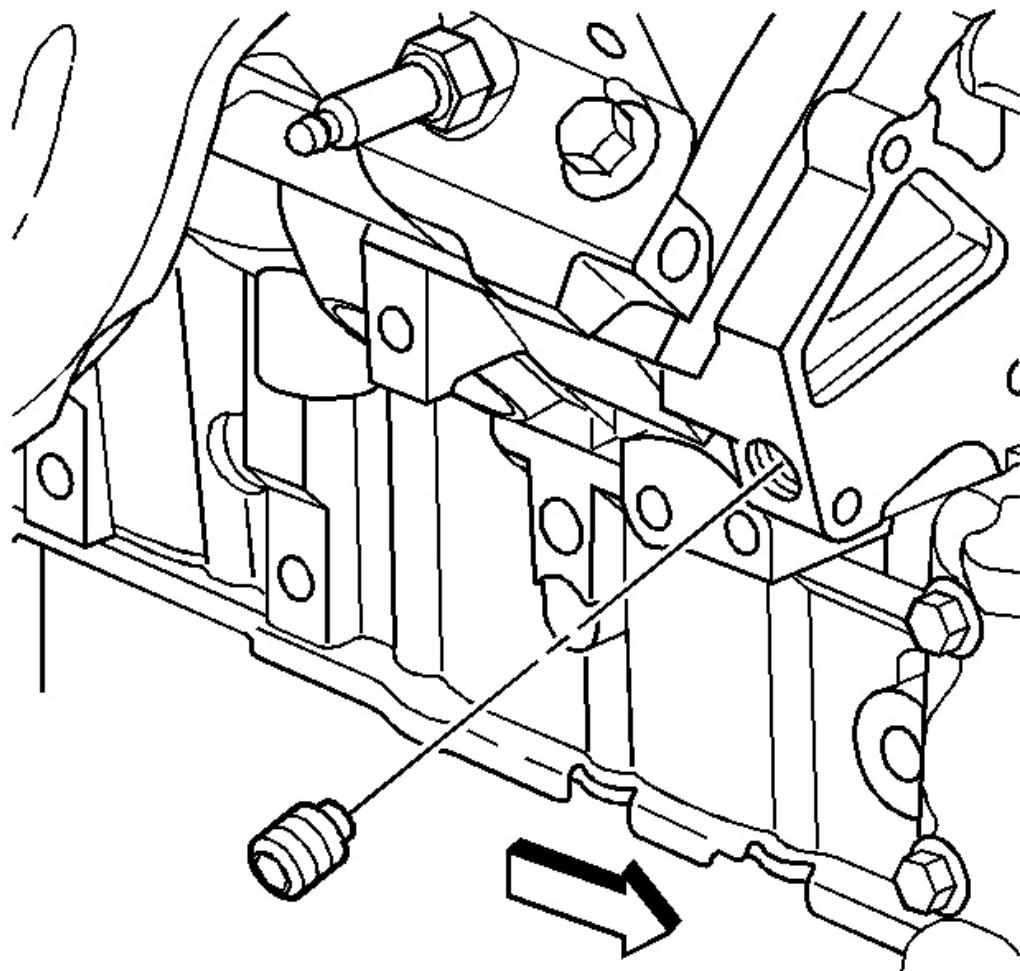
4. Install **J 6125-1B** to **J 41348** . See Special Tools.
5. Use **J 6125-1B** to remove the crankshaft main lower bearing caps. See Special Tools.



**Fig. 374: View Of Crankshaft, Bearings And Bearing Caps**  
Courtesy of GENERAL MOTORS CORP.

6. Remove the crankshaft.
7. Remove the upper main bearings from the engine block.

**Removal Procedure**



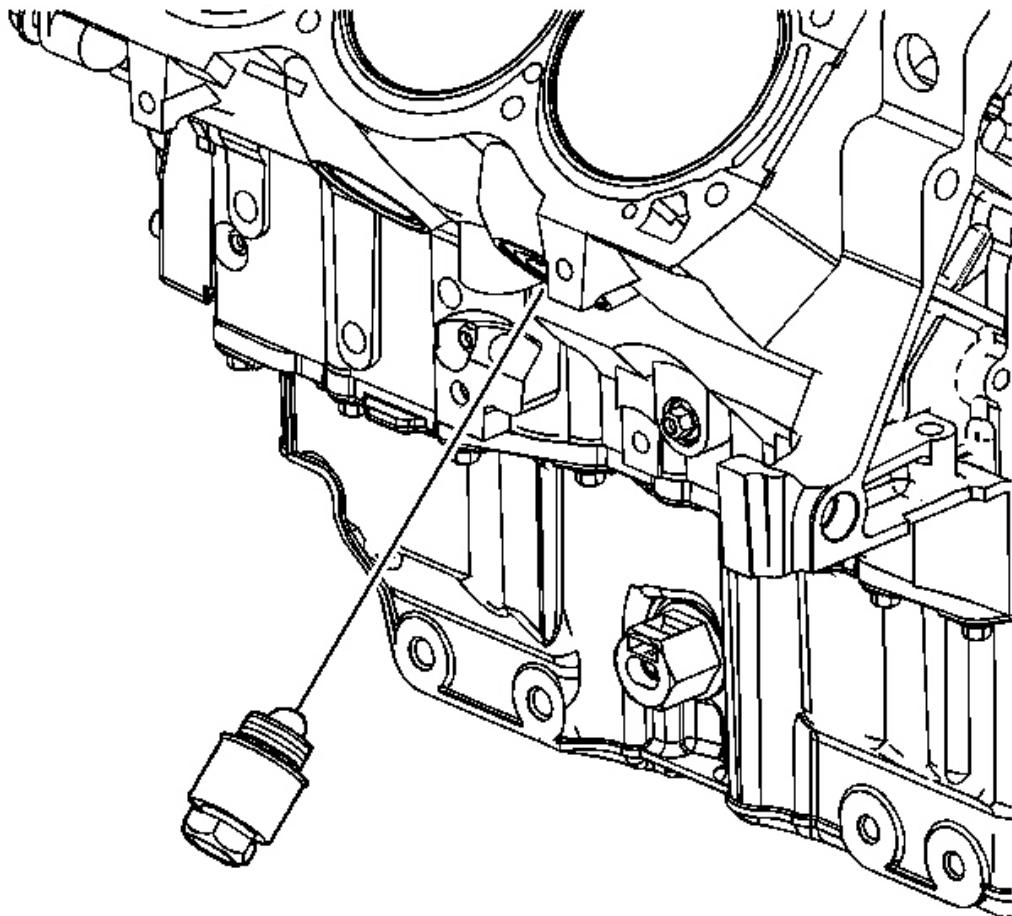
**Fig. 375: Locating Threaded Gallery Plugs**

**Courtesy of GENERAL MOTORS CORP.**

1. Remove the threaded coolant jacket plugs.

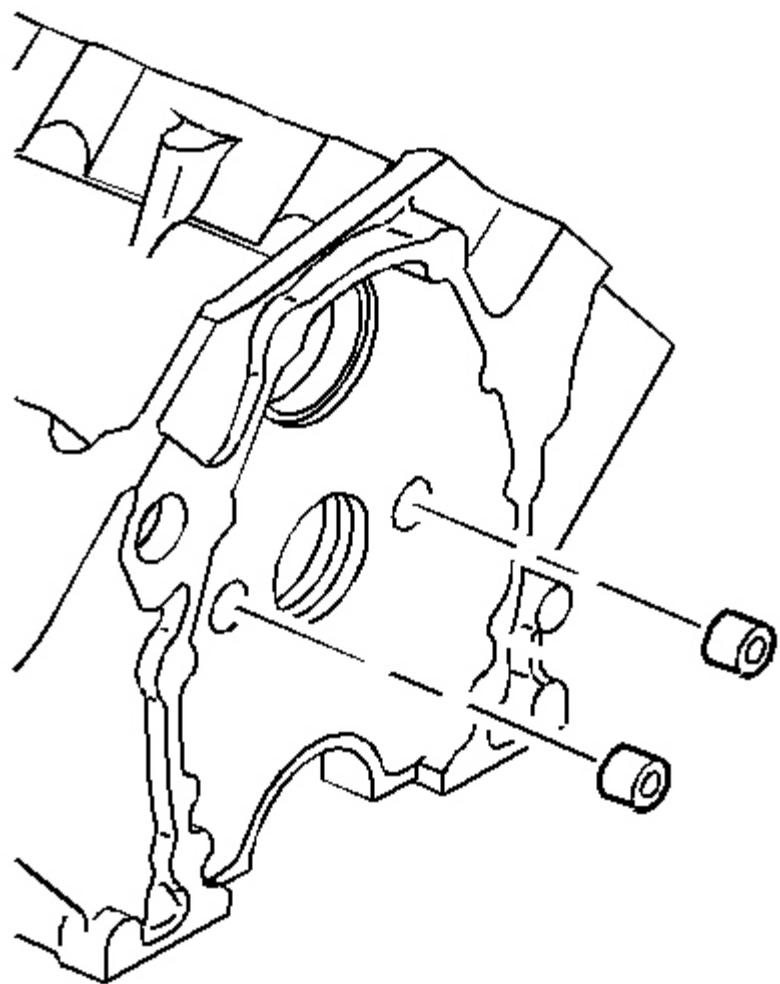
**2006 Buick Lucerne CXS**

2006 ENGINE Engine Mechanical - 3.8L - Lucerne



**Fig. 376: Threaded Engine Block Heater**  
Courtesy of GENERAL MOTORS CORP.

2. Remove the threaded engine block heater.



**Fig. 377: Locating Engine Block Plugs**  
Courtesy of GENERAL MOTORS CORP.

3. Remove the remaining plugs using the following procedure.
  1. Obtain a suitable self-threading screw.
  2. Drill a hole into the plug.
  3. Install the self-threading screw.
  4. Use the screw to pry out the plug.

## 2006 Buick Lucerne CXS

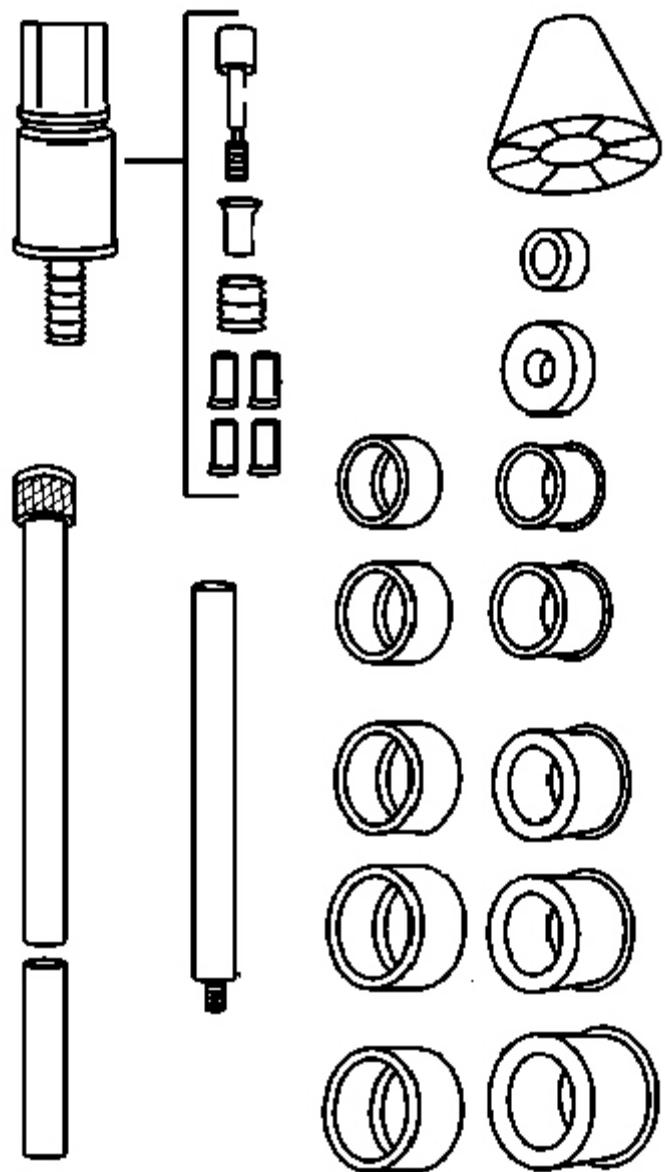
2006 ENGINE Engine Mechanical - 3.8L - Lucerne

### CAMSHAFT BEARING REMOVAL

#### Tools Required

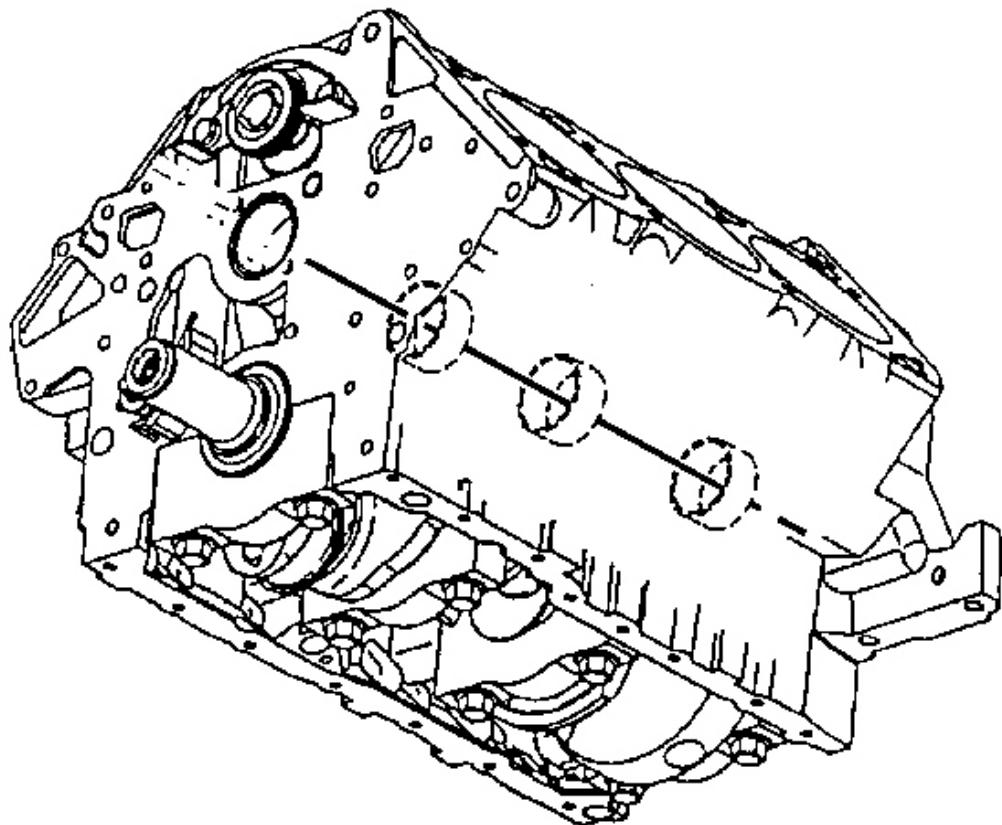
**J 33049** Camshaft Bearing Remover/Installer. See [Special Tools](#).

#### Removal Procedure



**Fig. 378: Camshaft Bearing Service Set**  
Courtesy of GENERAL MOTORS CORP.

1. Select the expander assembly and driving washer.
2. Assemble **J 33049**. See **Special Tools**.



**Fig. 379: Identifying Camshaft Bearings**

Courtesy of GENERAL MOTORS CORP.

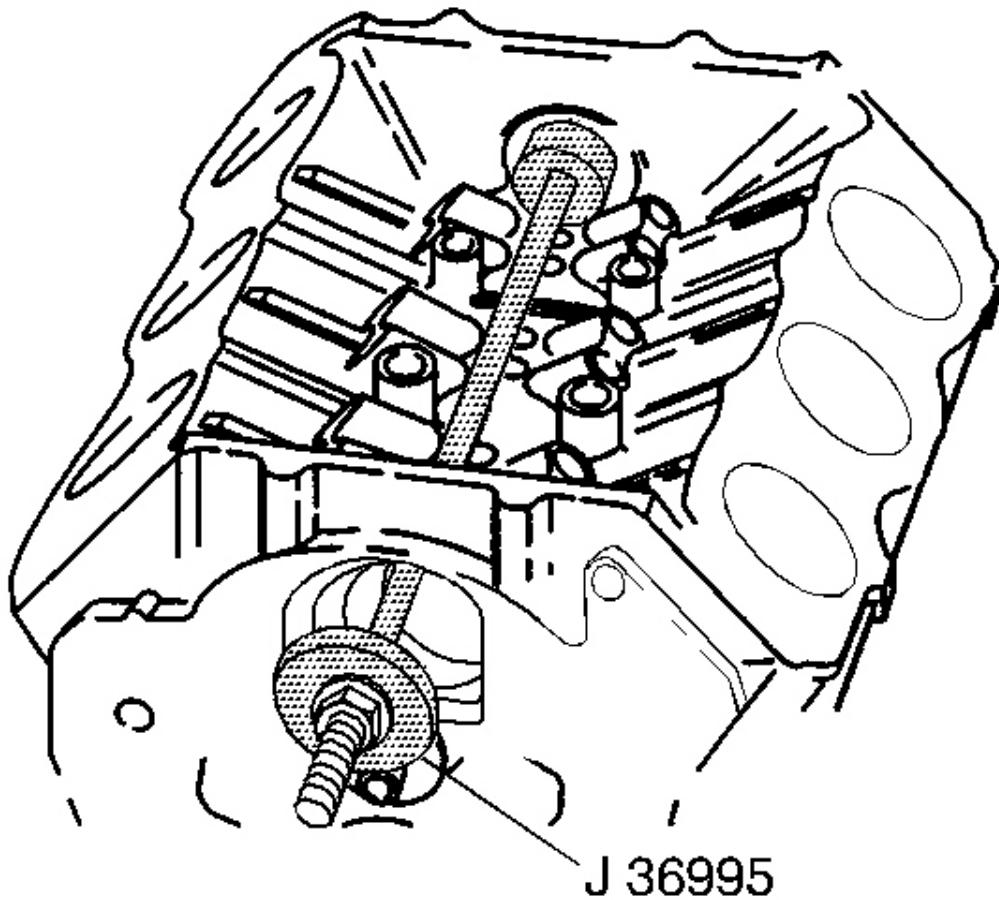
3. Drive out the camshaft bearings.

#### **BALANCE SHAFT BEARING AND/OR BUSHING REMOVAL**

##### **Tools Required**

**J 36995** Balance Shaft Bearing Remover/Installer. See **Special Tools**.

##### **Removal Procedure**



**Fig. 380: Removing Balance Shaft Bearing And/Or Bushing**  
Courtesy of GENERAL MOTORS CORP.

1. Use **J 36995** to remove the balance shaft bearing. See Special Tools.
2. Use **J 36995** to remove the balance shaft bushing. See Special Tools. It may take a considerable amount of force to loosen the bushing from the block bore.

#### ENGINE BLOCK CLEANING AND INSPECTION

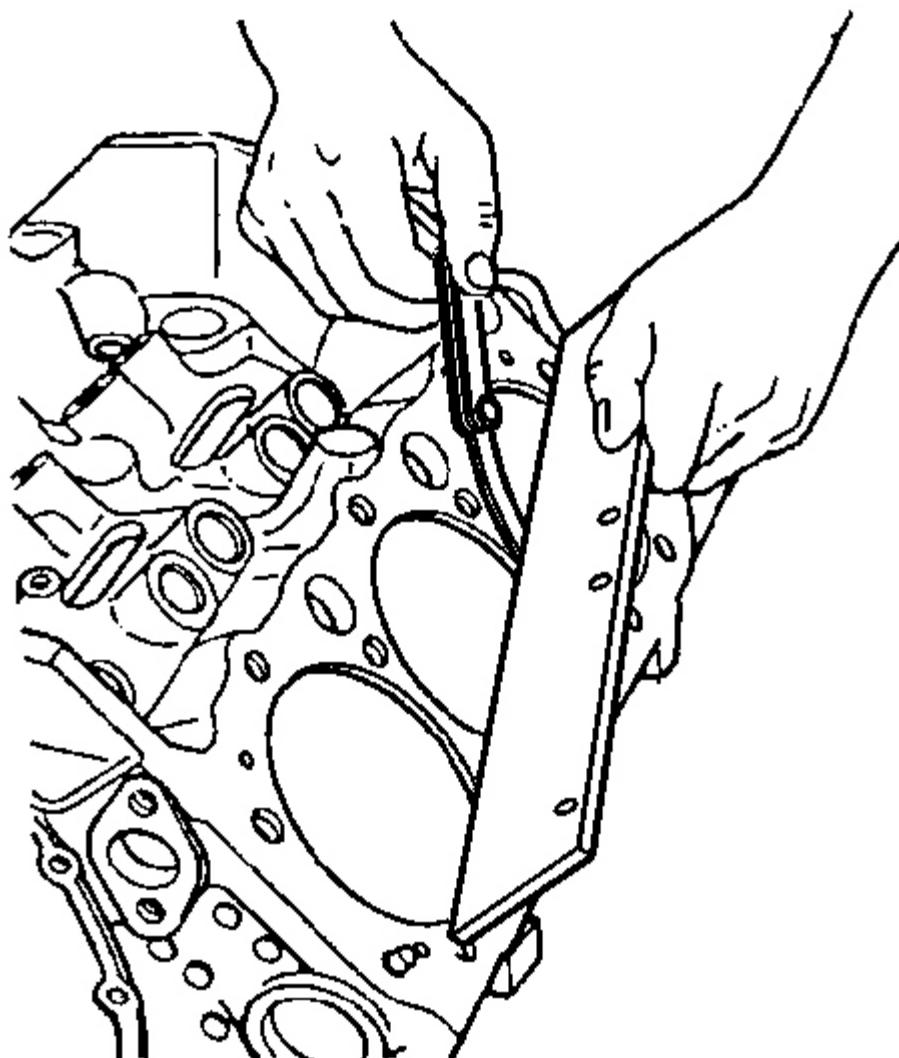
##### Tools Required

- **J 8087** Cylinder Bore Gage. See Special Tools.

- **J 8001** Dial Indicator Set. See [Special Tools](#).

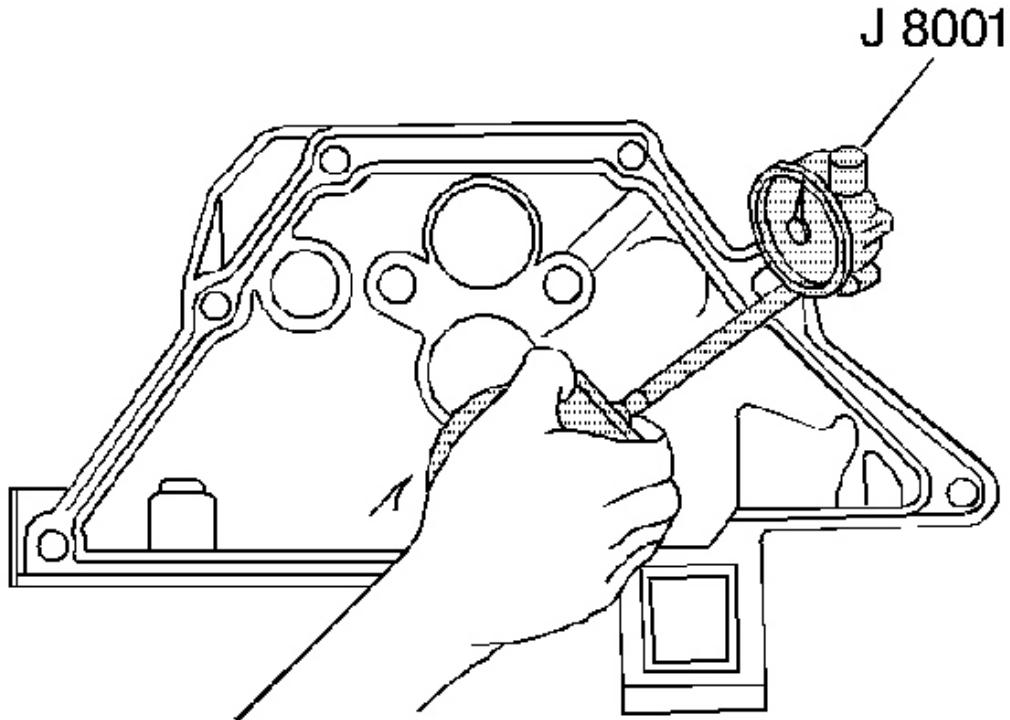
**Cleaning and Inspection Procedure**

1. Clean the sealing material from the gasket mating surfaces.
2. Boil the engine block in caustic solution.
3. Flush the engine block with clean water or steam.
4. Clean the oil passages.
5. Clean the blind holes.
6. Spray the cylinder bores and the machined surfaces with engine oil.
7. Inspect the threaded holes. Clean the holes with a tap. If necessary, drill out the holes and install thread inserts. Refer to [Thread Repair](#).



**Fig. 381: Testing Block Deck Surface For Flatness**  
Courtesy of GENERAL MOTORS CORP.

8. Use a straight edge and a feeler gage to check the deck surface for flatness. Carefully machine minor irregularities. Replace the block if more than 0.254 mm (0.010 in) must be removed.
9. Inspect the oil pan rail for nicks. Inspect the front cover attaching area for nicks. Use a flat mill file to remove any nicks.



**Fig. 382: Inspect Mating Surfaces Of Transmission Case**  
Courtesy of GENERAL MOTORS CORP.

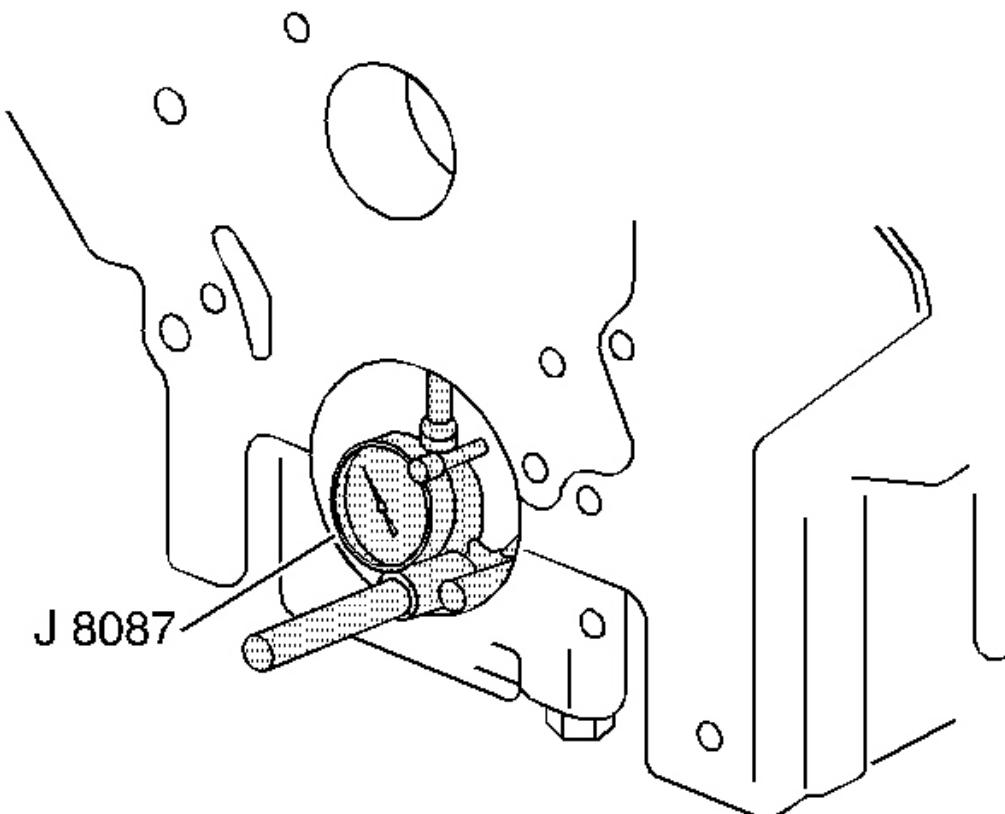
10. Inspect the mating surfaces of the transmission case.

**NOTE:** **A broken flywheel may result if the transmission case mating surface is not flat.**

11. Use the following procedure to measure the engine block flange runout at the six mounting bolt hole bosses:
  1. Temporarily install the crankshaft. Measure the crankshaft flange runout.
  2. Hold the gauge plate flat against the crankshaft flange.
  3. Place **J 8001** on the transmission mounting bolt hole boss. See **Special Tools**. Set the indicator to 0.
  4. Record the readings obtained from all of the bolt hole bosses. The measurements

should not vary more than 0.254 mm (0.010 in).

5. Recheck the crankshaft flange runout if the readings vary more than 0.254 mm (0.010 in).



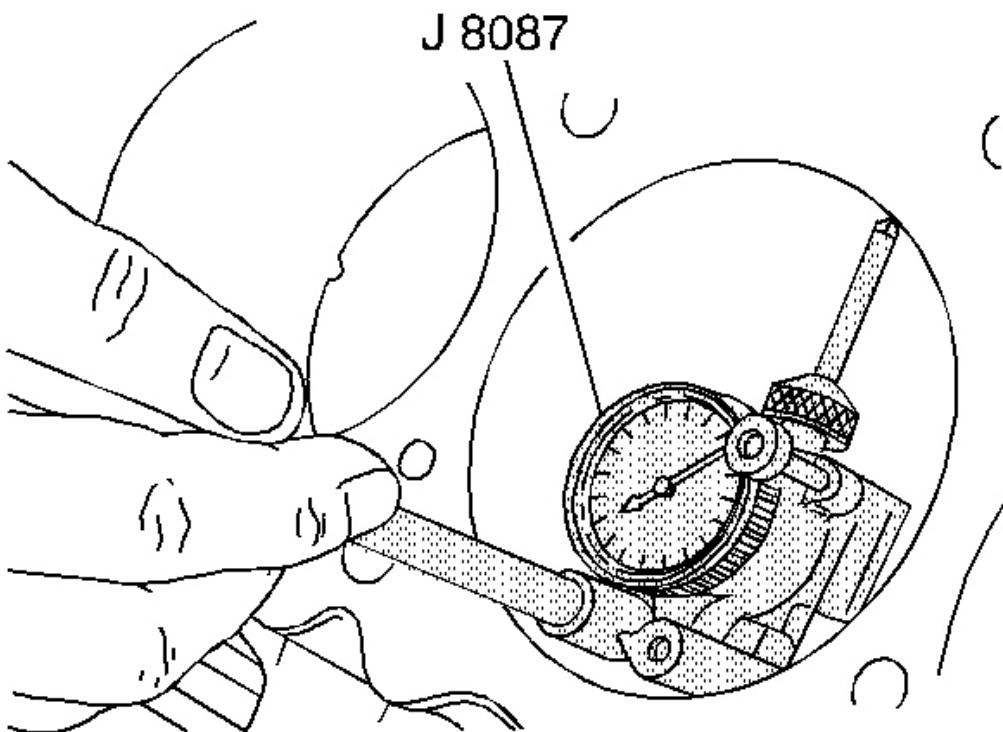
**Fig. 383: Inspecting Crankshaft Main Bearing Bores**  
Courtesy of GENERAL MOTORS CORP.

12. Inspect the crankshaft main bearing bores. Use **J 8087** to measure the bearing bore concentricity and alignment at the following locations:
  - The camshaft
  - The crankshaft

**IMPORTANT: Recondition the engine block with the crankshaft main bearing caps and the crankshaft main bearing cap side bolts**

**installed and tightened to specification.**

13. Ensure that the crankshaft main bearing caps are installed correctly. The arrows should point toward the front of the engine.
14. Replace the engine block if the bores are out of specification.



**Fig. 384: Inspecting Cylinder Bores Using J 8087**  
Courtesy of GENERAL MOTORS CORP.

15. Use **J 8087** to inspect the cylinder bores. Inspect for the following items:
  - Wear
  - Taper
  - Run-out
  - Ridging

**IMPORTANT: If the bore is worn beyond the limits, refit the bore with oversized pistons. Select the smallest available oversize piston. Refer to Cylinder Boring and Honing.**

16. Leave sufficient material to allow honing when fitting the piston.

## **CYLINDER BORING AND HONING**

### **Boring Procedure**

1. Before honing or boring, measure all of the new pistons. Select the smallest piston for the piston fitting. Slightly varied pistons in a set may provide correction, if the first piston is too loosely fitted.
2. Before using any type of boring bar, file the top of the engine block to remove any dirt or burrs. If the cylinder block is not straight, the boring bar may be tilted, causing the bored cylinder wall to have incorrect right angles to the crankshaft.
3. Carefully follow the instructions furnished by the manufacturer regarding use of equipment.
4. Install all crankshaft main bearing caps to specification when boring cylinders. Cover or tape the crankshaft bearings and other internal parts to protect these parts during the boring or honing operation.
5. Leave 0.03 mm (0.001 in) on the diameter for finish honing when performing the final cut with a boring bar. Carefully perform the honing and boring operation to maintain the specified clearances between pistons, rings and cylinder bores.

### **Honing Procedure**

1. Follow the manufacturer's recommendations for use, cleaning and lubrication when honing the cylinders. Use only clean, sharp stones of the proper grade for the amount of material to be removed. Dull, dirty stones cut unevenly and generate excessive heat. When using coarse or medium-grade stones, leave sufficient metal so all stone marks may be removed with the fine stones used for finishing to provide the proper clearance.
2. During the honing operation, thoroughly clean the cylinder bore. Check for the correct piston fit.
3. Make full strokes in the cylinder to eliminate taper. Repeatedly check the measurement at the top, the middle and the bottom of the cylinder bore.

**NOTE: Handle the pistons with care. Do not force the pistons through the cylinder until you hone the cylinder to the correct size. The piston can be distorted through careless handling.**

**IMPORTANT: The finish marks should be clean but not sharp. The finish marks should be free from imbedded particles and torn or folded metal.**

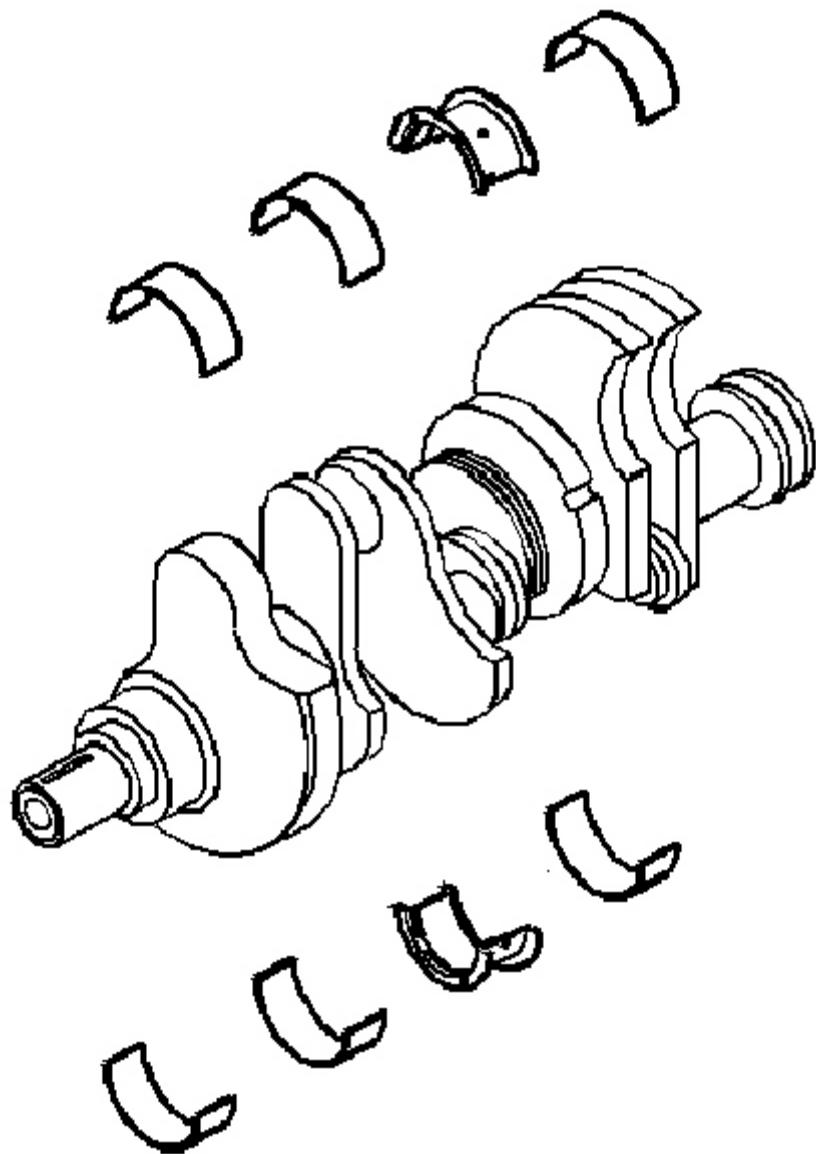
4. When finish honing a cylinder bore to fit a piston, move the hone up and down at a sufficient speed to obtain a fine and uniform surface finish in a cross hatch pattern.
5. Determine the finish hone cylinder measurement by measuring the piston to be installed and by adding the average of the clearance specification. Measure the block and the piston at normal room temperature.
6. True up the refinished cylinder bores. Final hone each cylinder bore to remove all stone or cutter marks.
7. After final honing and before the piston is checked for fit, clean the bores with hot water and detergent. Scrub the bores with a stiff bristle brush and rinse the bores thoroughly with hot water. Do not allow any abrasive material to remain in the cylinder bores. This abrasive material will wear the new rings, the cylinder bores and the bearings lubricated by the contaminated oil. After washing dry the bore.
8. Permanently mark the piston for the cylinder to which the piston has been fitted.
9. Apply clean engine oil to each bore to prevent rusting.

## CRANKSHAFT AND BEARING CLEANING AND INSPECTION

### Tools Required

**J 8087** Cylinder Bore Gage. See [Special Tools](#).

### Cleaning and Inspection Procedure



**Fig. 385: View Of Crankshaft & Bearings**  
Courtesy of GENERAL MOTORS CORP.

1. Clean the crankshaft of the following elements:
  - Oil

- Sludge
- Carbon

2. Inspect the crankshaft oil passages for obstructions.
3. Inspect the crankshaft keyway for nicks or wear.
4. Inspect the crankshaft threads.

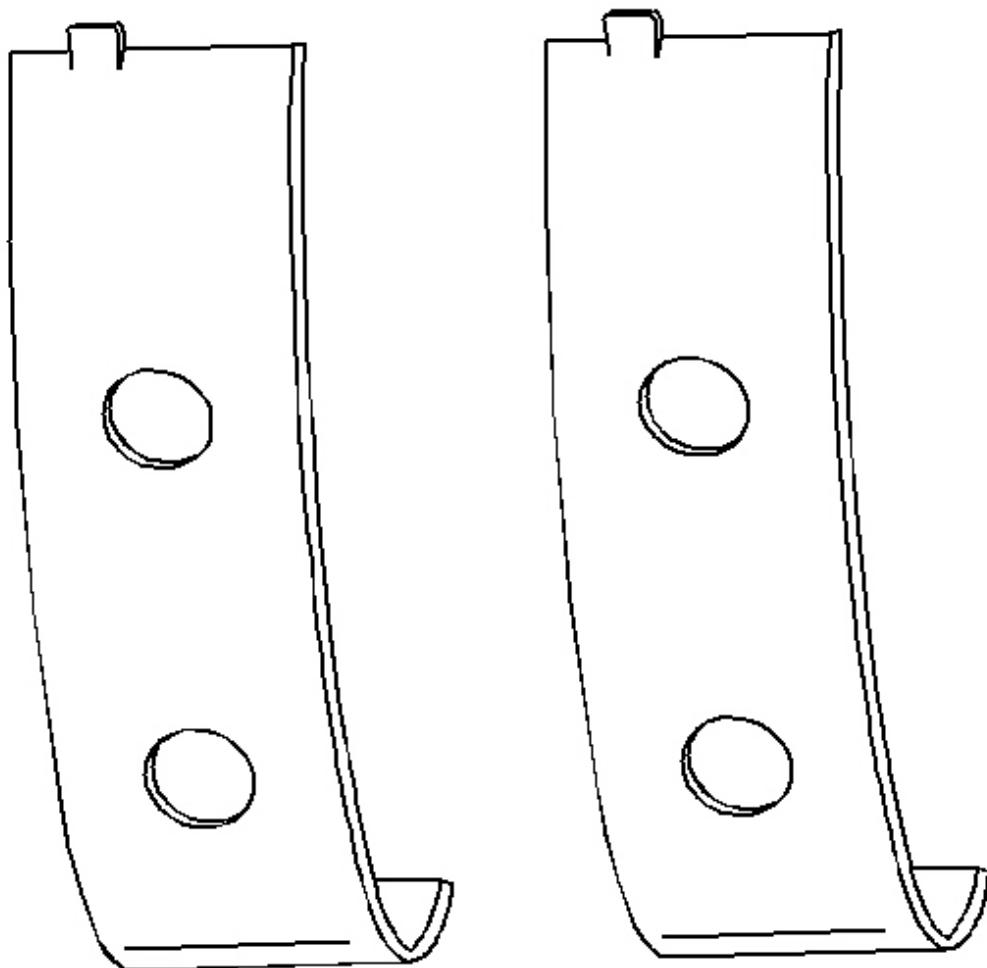
**IMPORTANT: If cracks, severe gouges or burned spots are found, the crankshaft must be replaced. Slight roughness may be removed with a fine polishing cloth soaked in clean engine oil. Burrs may be removed with a fine oil stone.**

5. Inspect the crankshaft bearing journals and the crankshaft thrust surfaces for the following conditions:
  - Cracks
  - Chips
  - Gouges
  - Roughness
  - Grooves
  - Overheating, discoloration

6. Inspect the corresponding crankshaft bearings for embedded foreign material and determine the source.

**IMPORTANT: Note the location of the crankshaft main bearing high spots. If they are not in line, the crankshaft is bent and must be replaced.**

7. Inspect the crankshaft bearings for uneven side-to-side wear. This may indicate a bent crankshaft or a tapered bearing journal.



**Fig. 386: View Of Crankshaft Bearings**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT: The crankshaft bearings are the precision insert type. The crankshaft bearings are available in standard and various undersizes.**

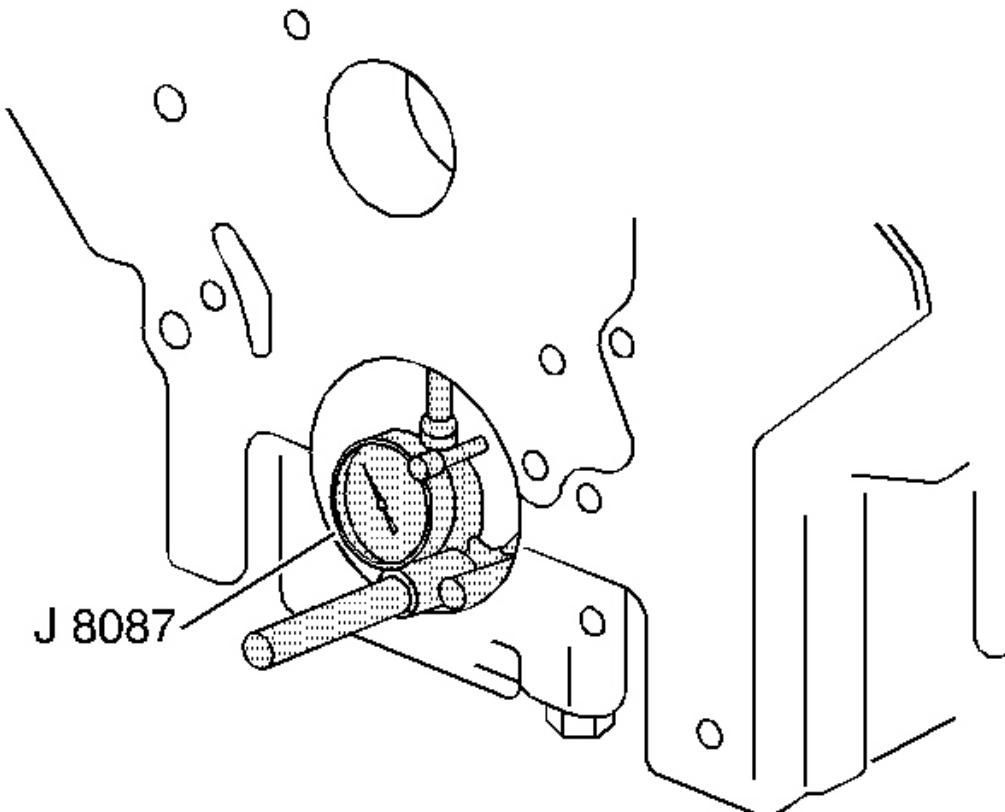
8. Inspect the outer surfaces of the crankshaft bearings for the following conditions:

- Wear - surface wear indicates either movement of the insert or high spots in the surrounding material, spot wear.

- Overheating or discoloration
- Looseness or rotation indicated by flattened tangs and wear grooves

9. Inspect the thrust surfaces of the main thrust bearing for the following conditions:

- Wear
- Grooving, grooves are caused by irregularities of the crankshaft thrust surface.



**Fig. 387: Inspecting Crankshaft Main Bearing Bores**

Courtesy of GENERAL MOTORS CORP.

**IMPORTANT: If crankshaft bearing failure is due to other than normal wear, investigate the cause. Inspect the crankshaft or connecting rod bearing bores.**

10. Using the **J 8087** inspect the connecting rod bearing bores or crankshaft main bearing bores using the following procedure. See **Special Tools**.

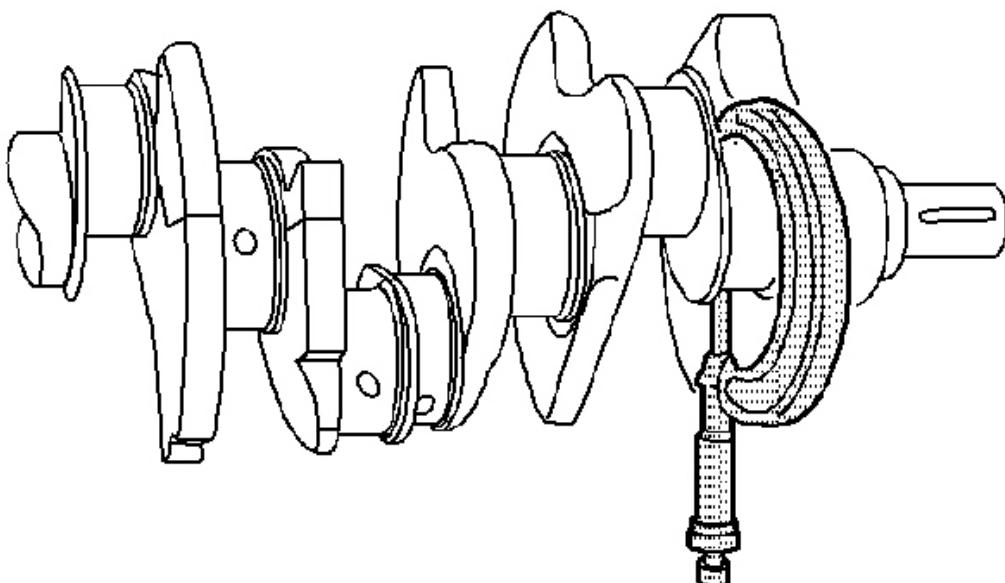
1. Tighten the bearing cap to specification.
2. Measure the bearing bore using **J 8087** for taper and out-of-round. See **Special Tools**.
3. No taper or out-of-round should exist.

#### Bearing Selection

Measure the bearing clearance to determine the correct replacement bearing insert size. There are two methods to measure bearing clearance. Method A gives more reliable results and is preferred.

- Method A yields measurement from which the bearing clearance can be computed.
- Method B yields the bearing clearance directly. Method B does not give any indication of bearing run-out.

#### Method A

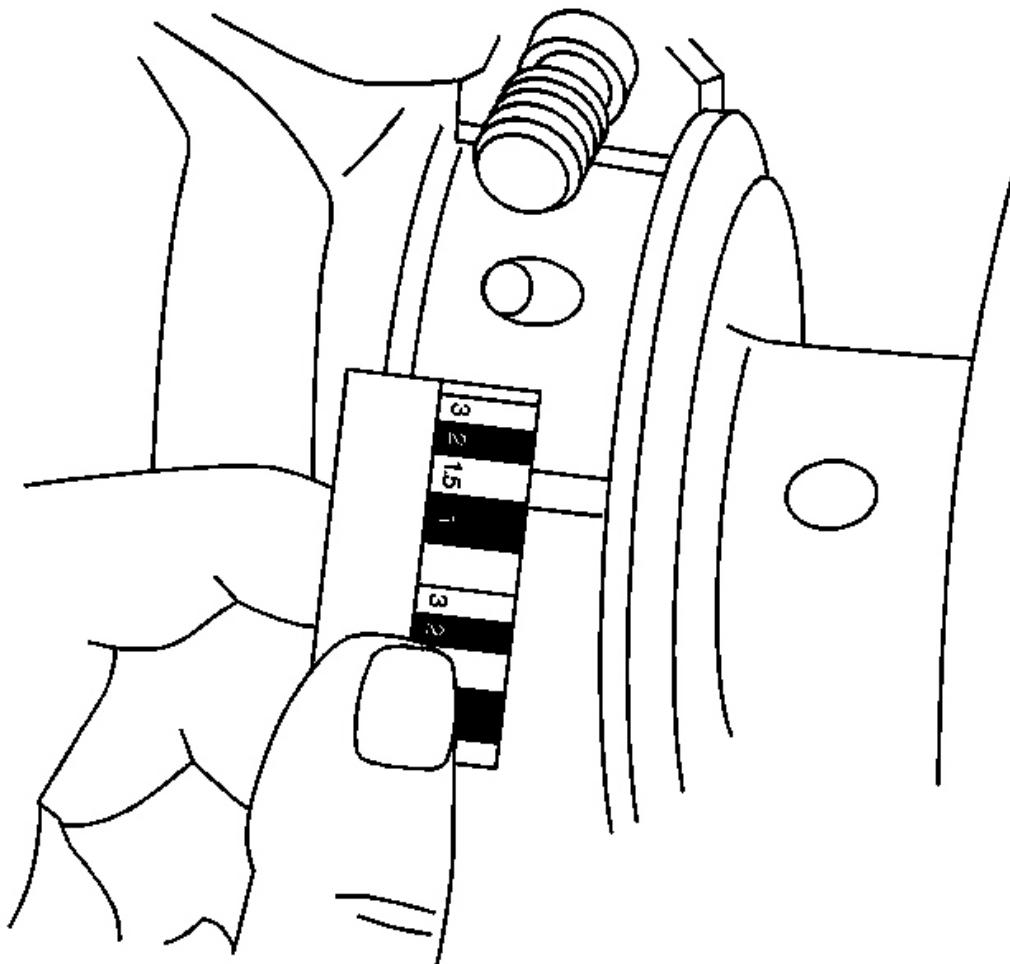


**Fig. 388: Measuring Crankshaft Bearing Journal Diameter**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT: Do not mix inserts of different nominal size in the same bearing bore.**

1. Measure the crankshaft bearing journal diameter with a micrometer in several places, 90 degrees apart. Average the measurements.
2. Measure the crankshaft bearing journal taper and runout.
3. Install the crankshaft bearing inserts. Tighten the bearing cap bolts to specification.
4. Measure the connecting rod inside diameter in the same direction as the length of the rod with an inside micrometer.
5. Measure the crankshaft main bearing inside diameter with an inside micrometer.
6. Select a set of bearing inserts that will produce the desired clearance.
7. If the specified clearances cannot be met, the crankshaft journals must be reconditioned and undersized bearing inserts installed.

**Method B**



**Fig. 389: Measuring Gaging Plastic**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT: Do not mix inserts of different nominal size in the same bearing bore.**

1. Clean the used bearing inserts.
2. Install the used bearing inserts.
3. Place a piece of gaging plastic across the entire bearing width.
4. Install the bearing caps.

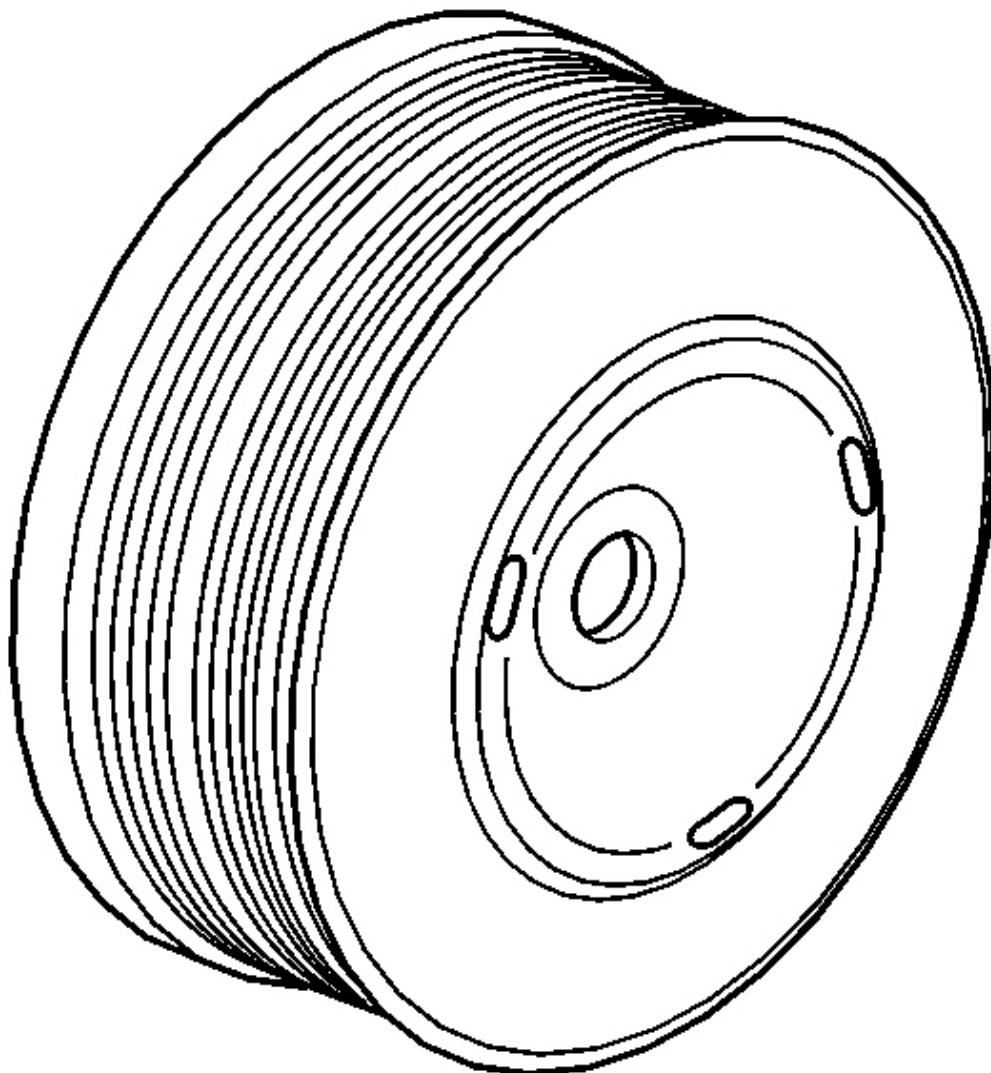
**NOTE:** In order to prevent the possibility of cylinder block or crankshaft bearing cap damage, the crankshaft bearing caps are tapped into the cylinder block cavity using a brass, lead or a leather mallet before the attaching bolts are installed. Do not use attaching bolts to pull the crankshaft bearing caps into the seats. Failure to use this process may damage a cylinder block or a bearing cap.

5. Install the bearing cap bolts to specification.

**IMPORTANT: Do not rotate the crankshaft.**

6. Remove the bearing cap, leaving the gaging plastic in place. It does not matter whether the gaging plastic adheres to the journal or to the bearing cap.
7. Measure the gaging plastic at its widest point with the scale printed on the gaging plastic package.
8. Remove the gaging plastic.
9. Select a set of bearing inserts that will produce the desired clearance.

#### **CRANKSHAFT BALANCER CLEANING AND INSPECTION**

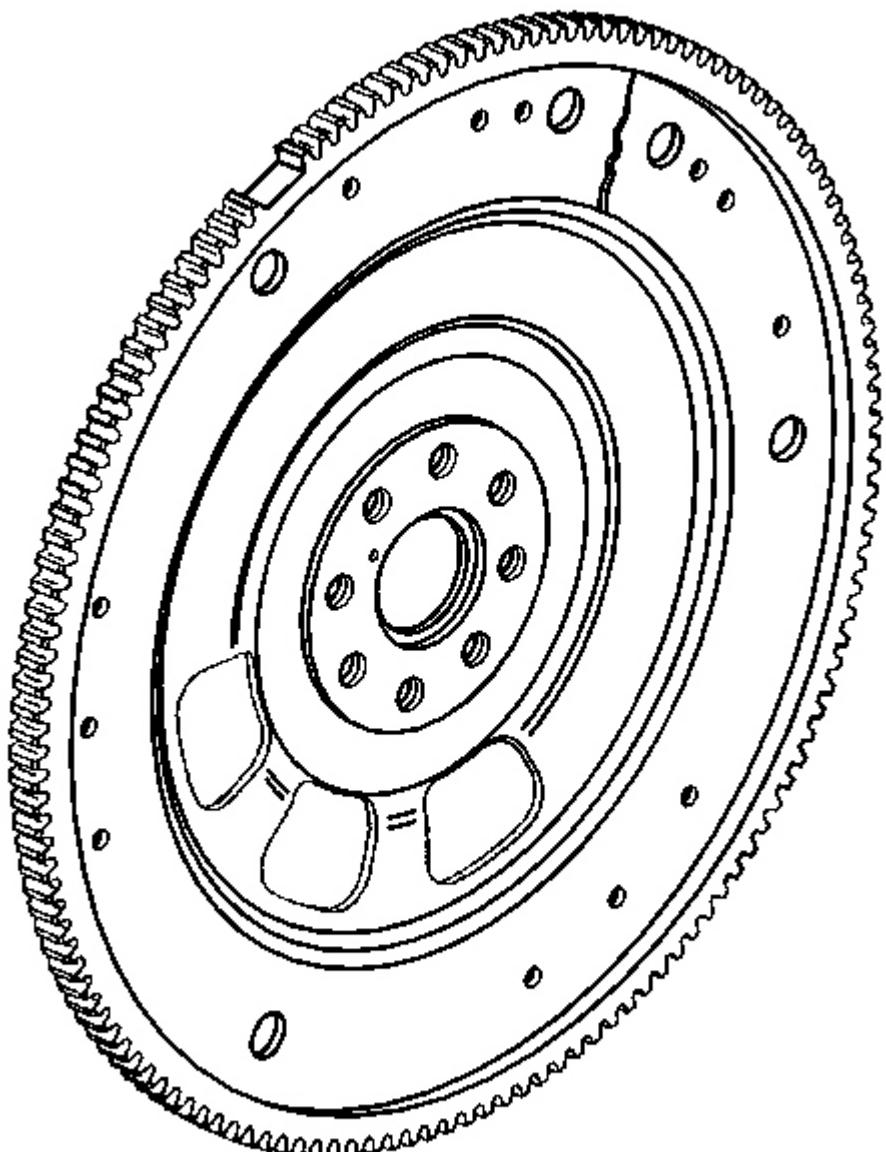


**Fig. 390: View of Crankshaft Balancer**  
Courtesy of GENERAL MOTORS CORP.

- Inspect the crankshaft balancer for damage.
- Inspect the outside of the crankshaft balancer mounting shaft for grooves.
- Replace the crankshaft balancer if grooves are present and appear to be causing an oil leak.

Cleaning and Inspection Procedure

**IMPORTANT: In order to maintain the proper component balance, contact surface taper and heat transfer, manual transmission flywheels are NOT to be machined.**



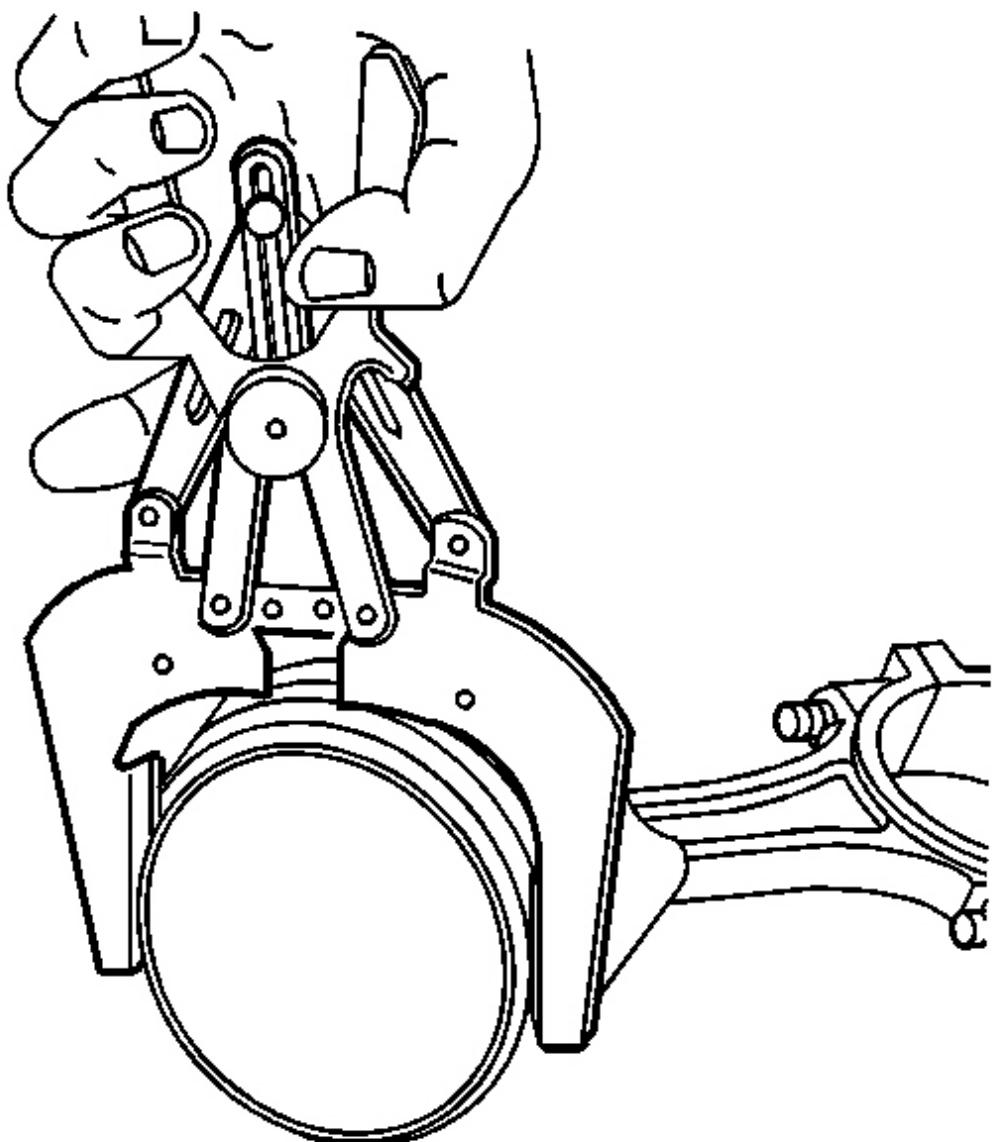
**Fig. 391: Identifying Engine Flywheel**

**Courtesy of GENERAL MOTORS CORP.**

1. Clean the flywheel.
2. Inspect the engine flywheel for damage and cracks.
3. Inspect the engine flywheel ring gear for damaged teeth.
4. Replace the flywheel if any damage is found.

**PISTON AND CONNECTING ROD DISASSEMBLE**

**Disassembly Procedure**

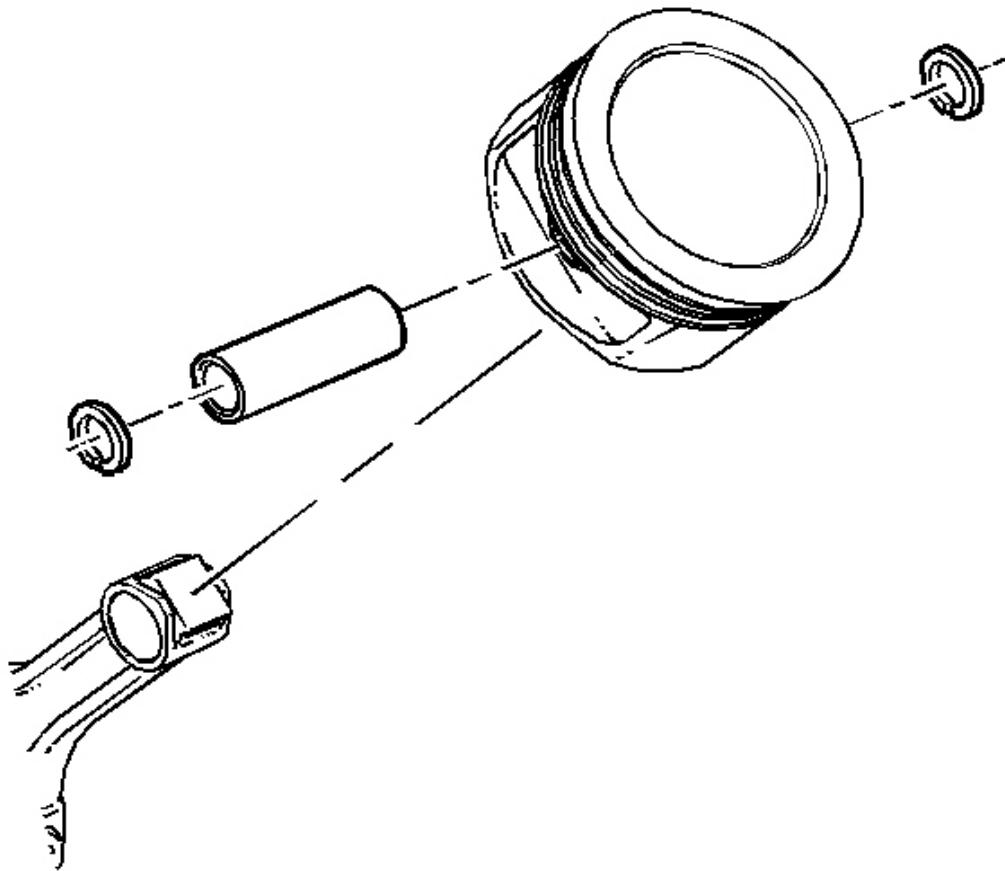


**Fig. 392: Cleaning The Piston Ring Grooves With Suitable Ring Groove Cleaning Tool**

Courtesy of GENERAL MOTORS CORP.

**CAUTION: Handle the piston carefully. Worn piston rings are sharp and may cause bodily injury.**

1. Remove the piston rings. Use a suitable tool to expand the rings. Piston rings must not be reused.



**Fig. 393: View Of Piston Pin, Piston, Clips & Connecting Rod**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** When removing or installing the piston pin retainer and piston pin do not damage the piston or the retaining groove in the piston. Damage to the piston or retaining groove can lead to severe engine damage.

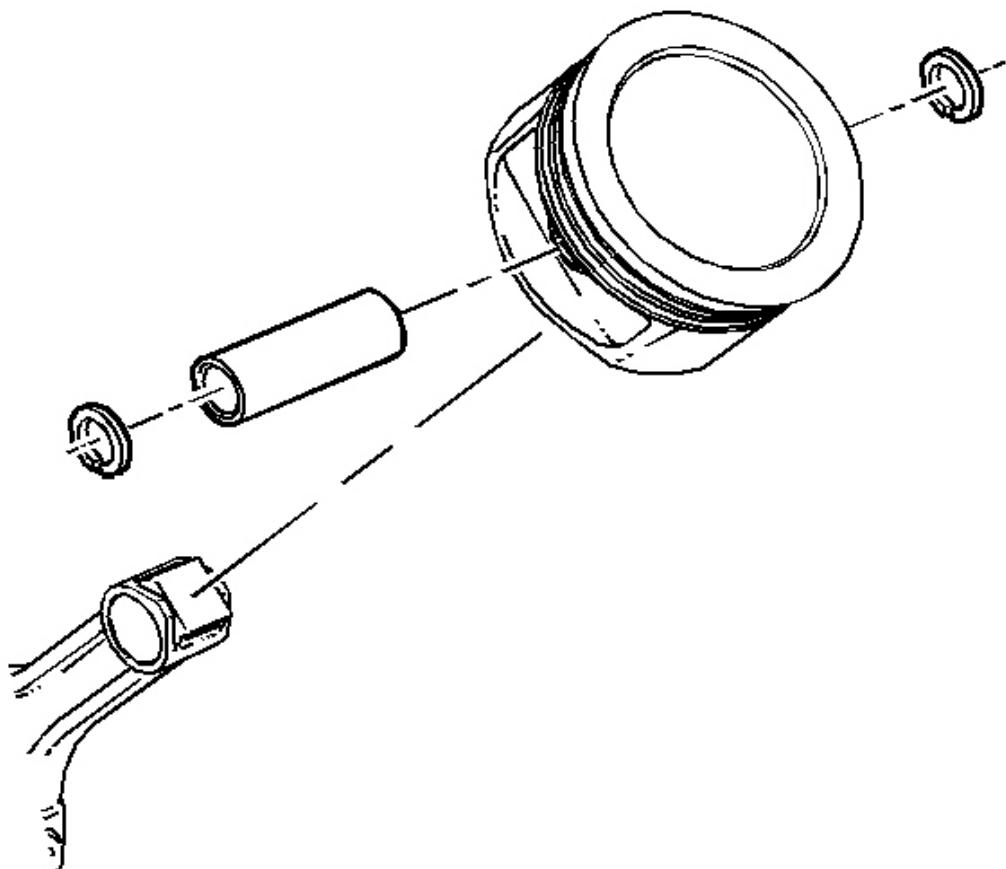
2. Remove the piston pin retaining clips.

3. Remove the piston pin.

## PISTON, CONNECTING ROD AND BEARING CLEANING AND INSPECTION

**CAUTION: Refer to Cleaning Solvent Caution .**

Cleaning and Inspection Procedure



**Fig. 394: View Of Piston Pin, Piston, Clips & Connecting Rod**  
Courtesy of GENERAL MOTORS CORP.

1. Clean the piston and connecting rod in solvent.

**CAUTION: Refer to Safety Glasses and Compressed Air Caution .**

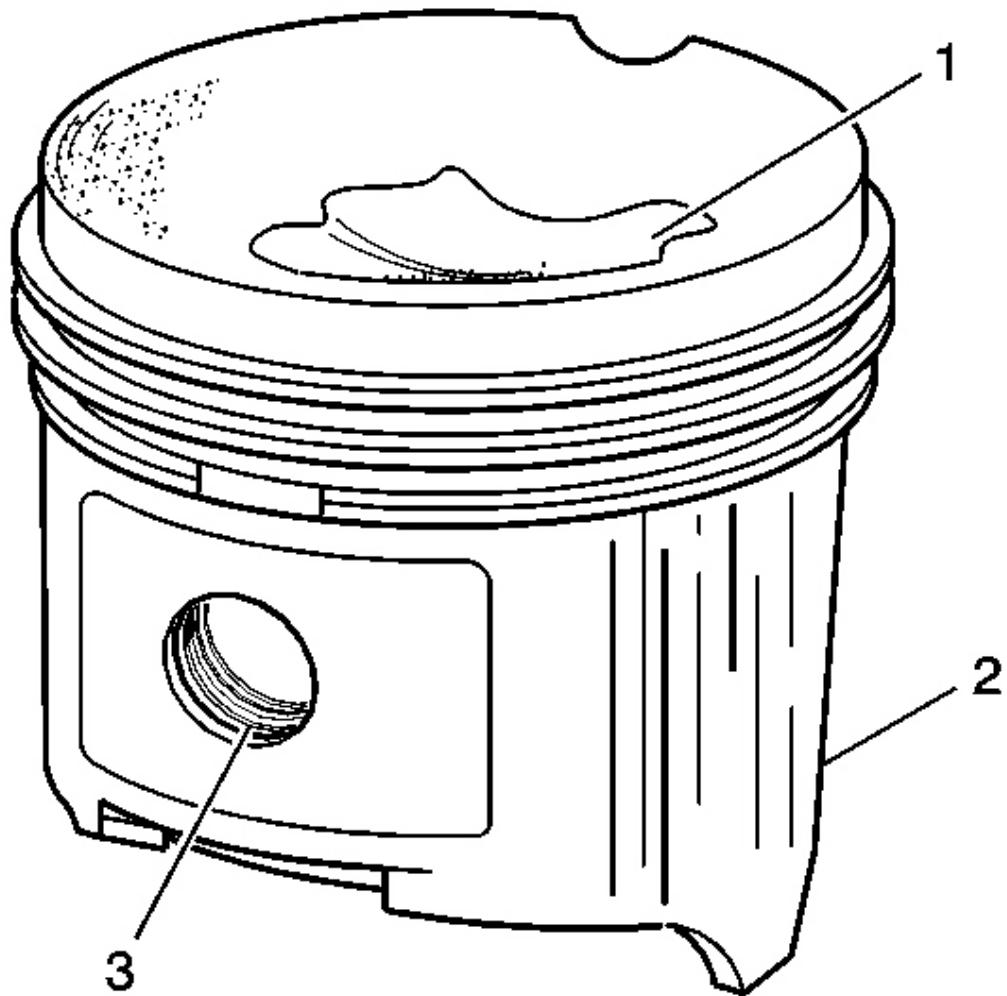
2. Dry the components with compressed air.

**NOTE: The piston ring groove must only be cleaned with a ring groove cleaning tool. Proper engine performance and durability depends on the straightness and smoothness of the ring groove. Cleaning the piston ring groove with an improper tool can damage the piston ring groove and effect the performance and durability of the engine.**

3. Clean the piston ring grooves with a suitable ring groove cleaning tool.

**NOTE: The oil lubrication holes/slots must be cleaned with a suitable tool. Proper engine performance and durability depends on the cleanliness and smoothness of the holes/slots. Cleaning the oil lubrication holes/slots with an improper tool may damage the oil lubrication holes/slots and effect the performance and durability of the engine.**

4. Clean the piston oil lubrication holes and slots.

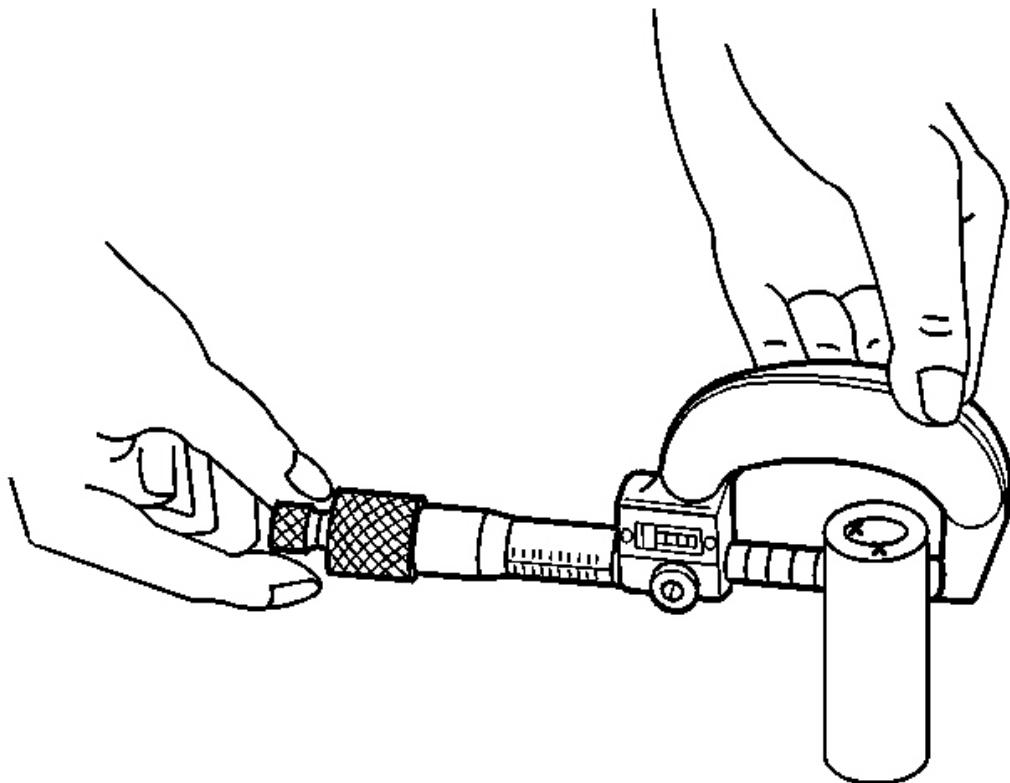


**Fig. 395: Identifying Piston Damage Inspection Areas**  
Courtesy of GENERAL MOTORS CORP.

5. Inspect the piston for the following conditions:
  - Eroded areas (1) on top of the piston
  - Scuffed or damaged skirt (2)
  - Damage to the pin bore (3)
  - Cracks in the piston ring lands, the piston skirt or the pin bosses
  - Piston ring grooves for nicks, burrs or other warpage which may cause the piston ring

to bind.

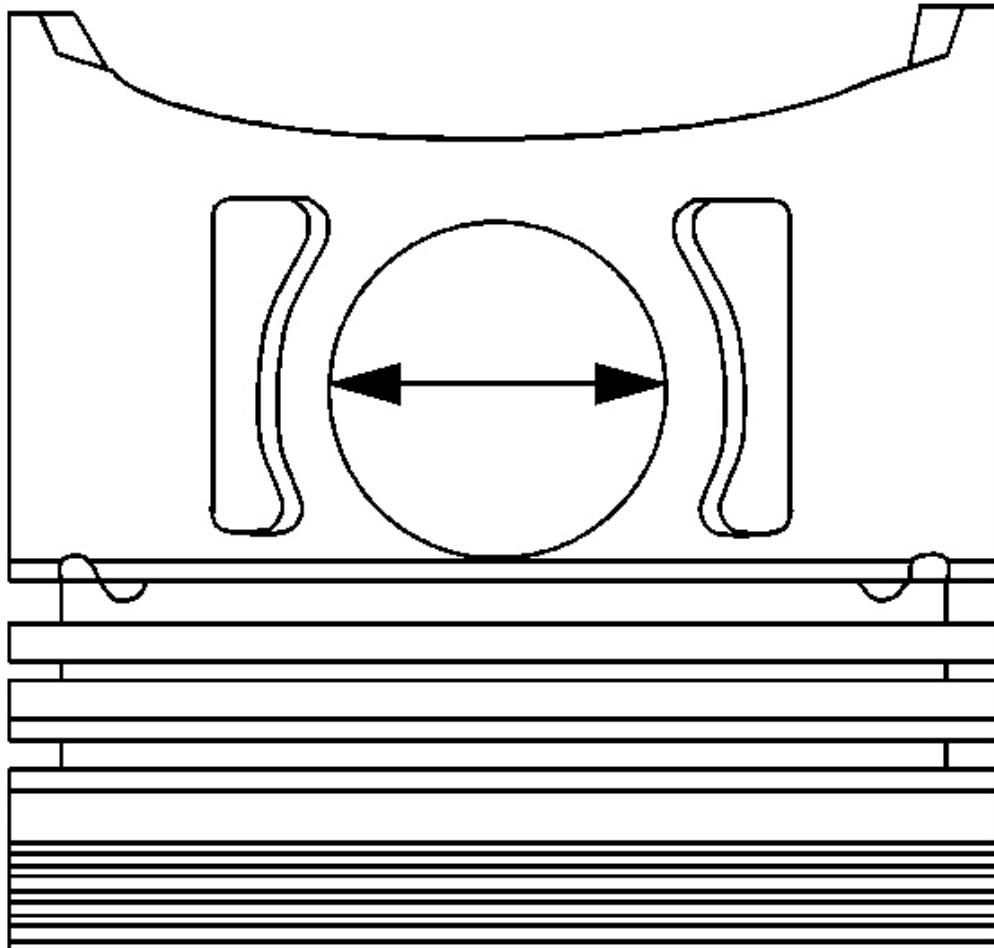
6. Inspect the piston for scoring, wear or other damage.



**Fig. 396: Measuring Piston Pin Diameter**

Courtesy of GENERAL MOTORS CORP.

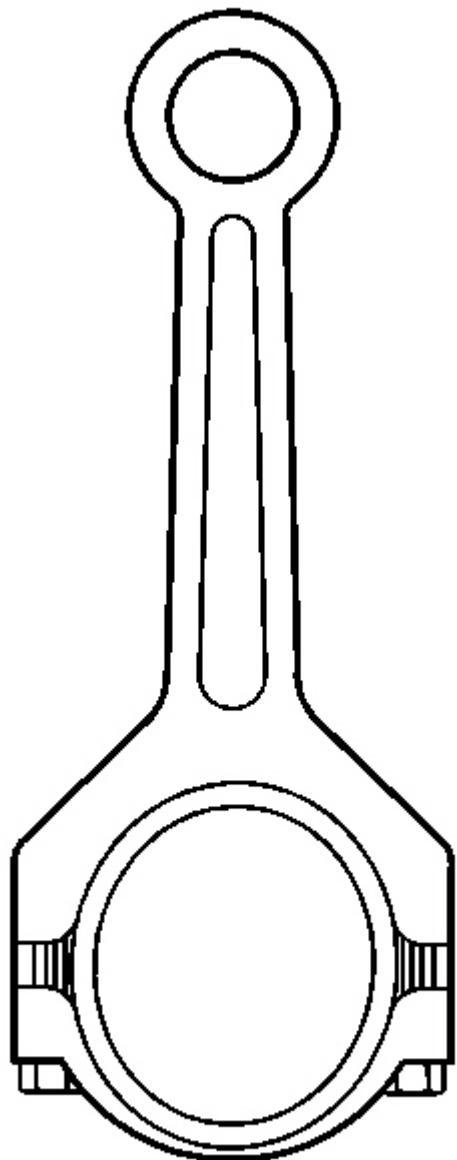
7. To determine the piston-to bore clearance, use a micrometer and measure the piston pin.



**Fig. 397: Measuring The Piston Pin Bore**

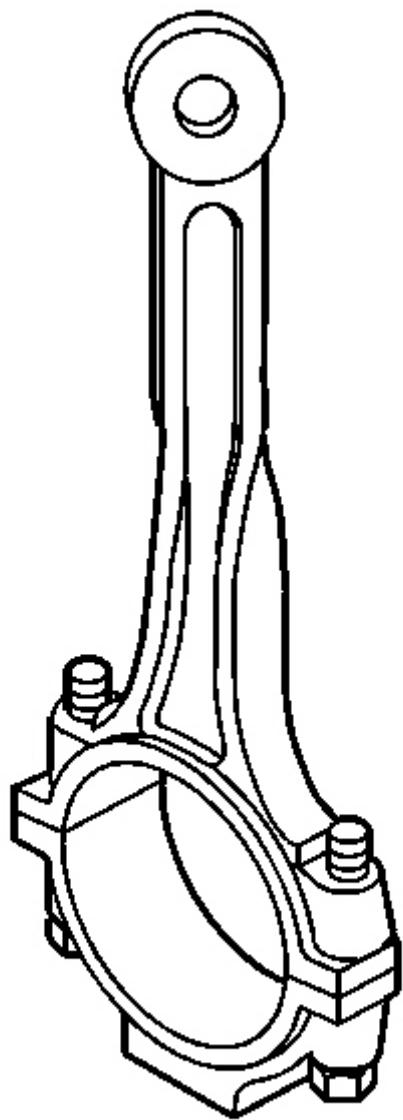
Courtesy of GENERAL MOTORS CORP.

8. To determine the piston pin-to bore clearance, use an inside micrometer and measure the piston pin bore.
9. To determine the piston pin-to-bore clearance, subtract the piston pin diameter from the piston pin bore diameter.



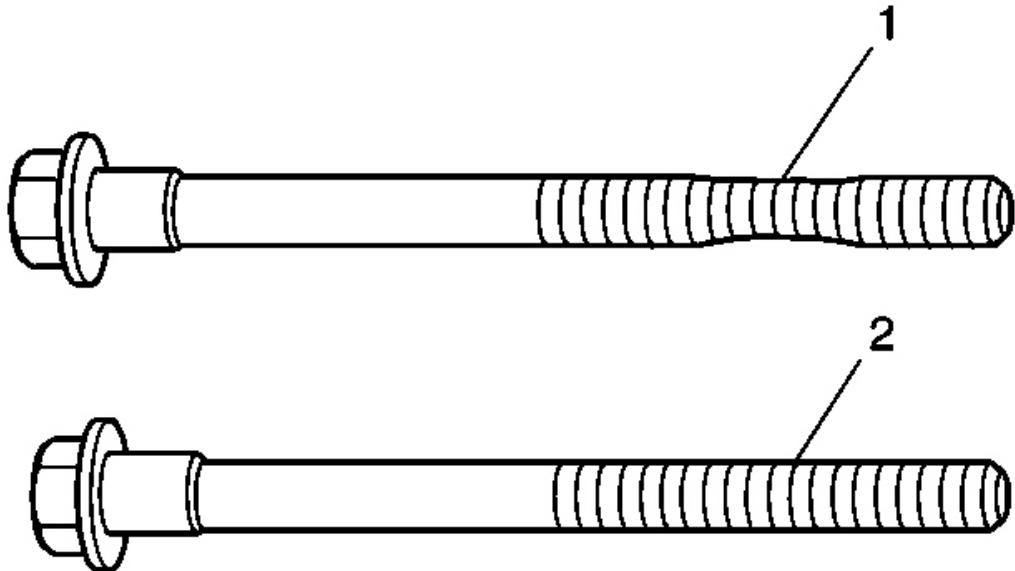
**Fig. 398: View Of Connecting Rod**  
Courtesy of GENERAL MOTORS CORP.

10. Inspect the connecting rod for an out-of-round bearing bore.



**Fig. 399: Identifying Twisted Connecting Rod**  
Courtesy of GENERAL MOTORS CORP.

11. Inspect the connecting rod for twisting.



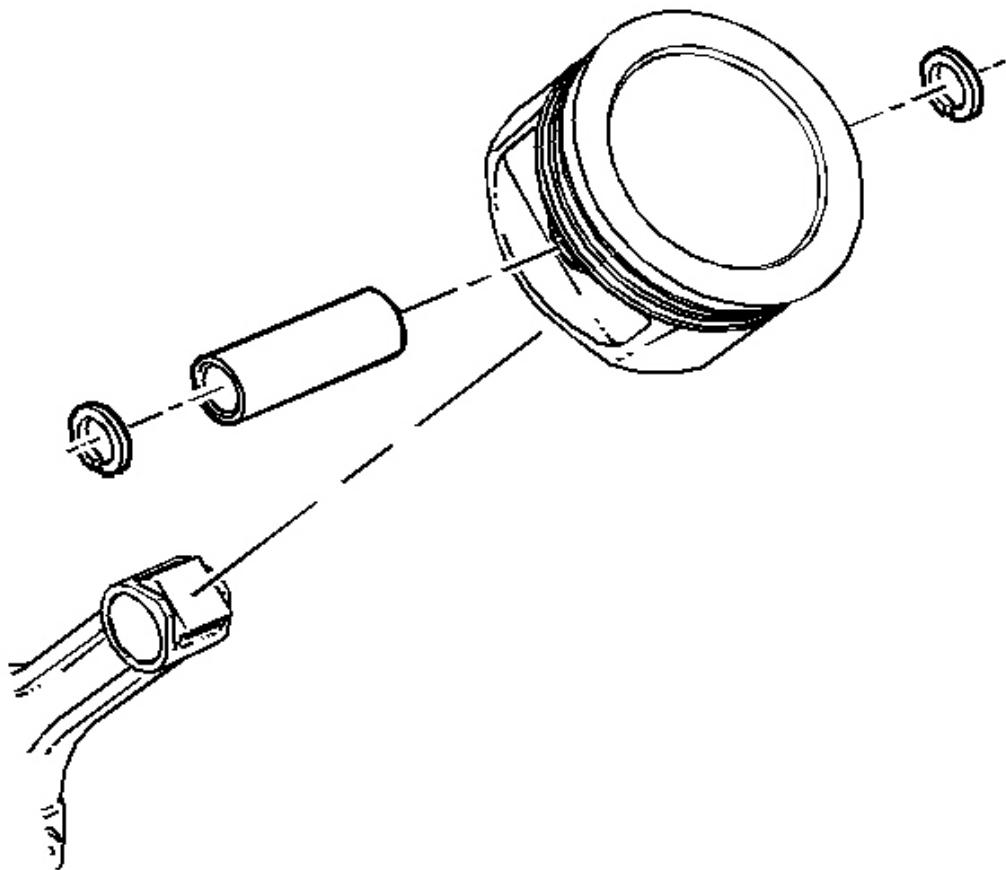
**Fig. 400: Inspecting Connecting Rod Cap Bolts**

Courtesy of GENERAL MOTORS CORP.

12. Inspect the connecting rod cap bolts for stretch (compare to known good bolt) (1) is a stretched bolt, (2) is a new or good bolt.

#### **PISTON AND CONNECTING ROD ASSEMBLE**

##### **Assembly Procedure**

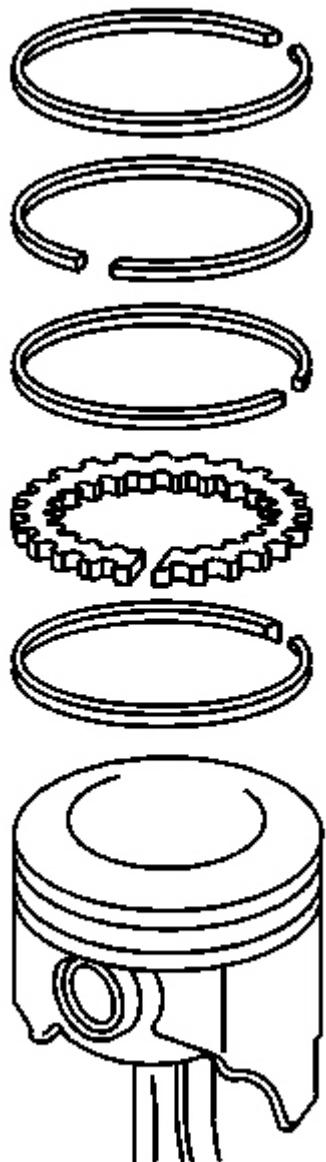


**Fig. 401: View Of Piston Pin, Piston, Clips & Connecting Rod**  
Courtesy of GENERAL MOTORS CORP.

1. Coat the piston pin with oil.
2. Install one piston pin retainer into the retaining groove.
3. Install the connecting rod and piston pin. The connecting rod can be installed in either direction. Push the piston pin in until it bottoms against the installed piston pin retainer.
4. Install the second piston pin retainer.
5. Ensure the piston pin moves freely.

**2006 Buick Lucerne CXS**

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**Fig. 402: Exploded View Of Piston Rings**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Use a piston ring expander to install the piston rings. The rings may be damaged if expanded more than necessary.

**IMPORTANT: To provide an effective compression and oil seal, the ring gaps must be staggered a minimum of 90 degrees.**

6. Using the piston ring pliers, install the piston rings onto the piston.
  1. Install the oil control ring spacer into the bottom groove of the piston.
  2. Install the lower oil control ring.

The oil control rings do not have a dimple or orientation mark and may be installed in either direction.

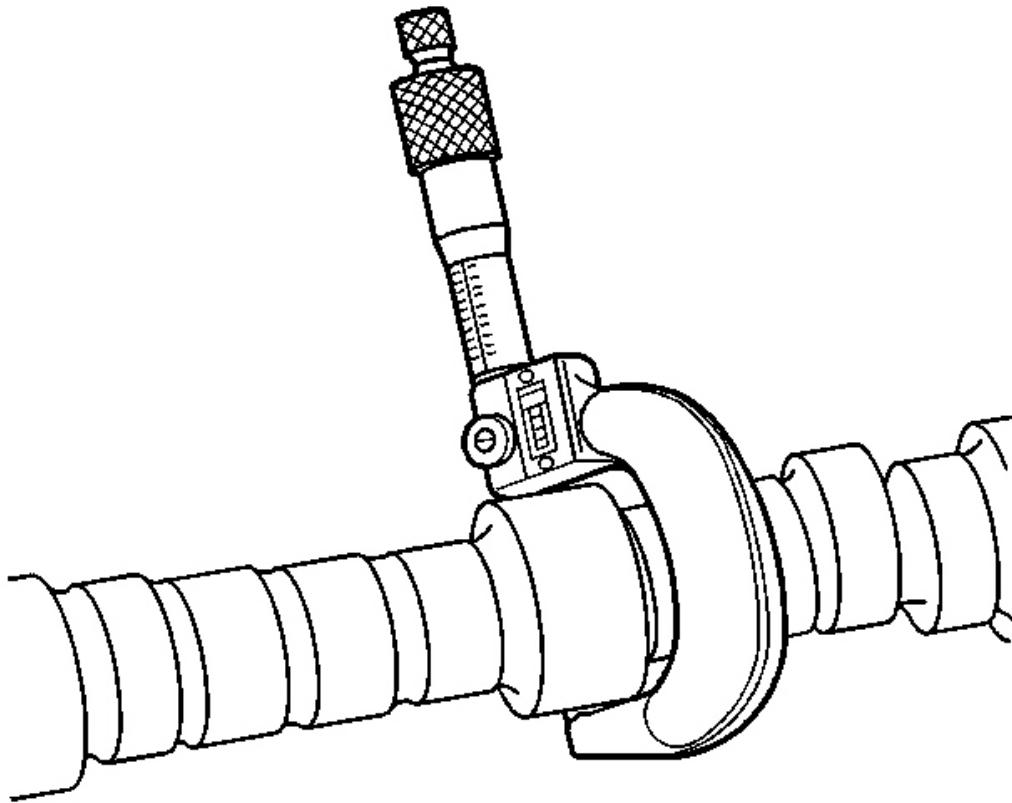
3. Install the upper oil control ring.
4. Install the middle compression ring with the dot facing up.
5. Install the top compression ring in either direction. The ring has no orientation markings.

## CAMSHAFT AND BEARINGS CLEANING AND INSPECTION

### Tools Required

**J 7872** Magnetic Base Indicator Set. See **Special Tools**.

### Cleaning and Inspection Procedure



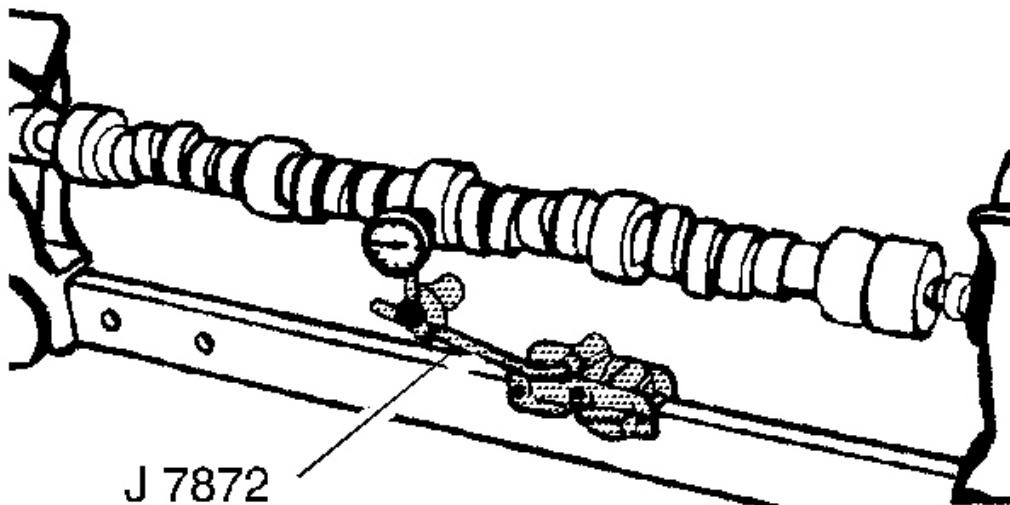
**Fig. 403: Measure Camshaft Journals With Micrometer**

Courtesy of GENERAL MOTORS CORP.

**IMPORTANT: The camshaft and lifters become mated to each other through both normal and premature wear. If the camshaft must be replaced, ALL lifters must be replaced as well.**

1. Measure the camshaft journals with a micrometer.

If the camshaft journals are not within specifications, replace the camshaft. The measurement should be 47.655-46.858 mm (1.8462-1.8448 in). If the measurement is not within specifications the engine camshaft must be replaced.



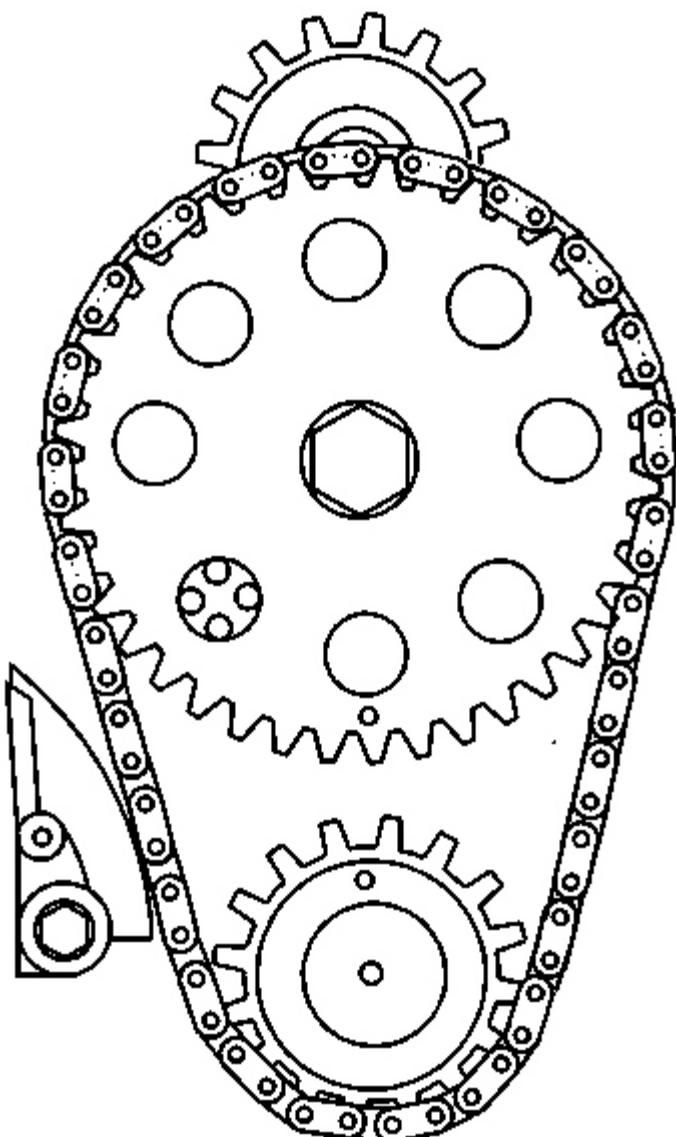
**Fig. 404: Measuring Camshaft Runout**

Courtesy of GENERAL MOTORS CORP.

2. Measure the camshaft runout using **J 7872** . See **Special Tools**.
  1. Mount the camshaft in V-blocks between centers.
  2. Use **J 7872** to check the intermediate camshaft journal. See **Special Tools**.
3. If the runout exceeds specifications, the camshaft is bent and should be replaced. If the camshaft journals are more than 0.025 mm (0.0010 in) out-of-round, then replace the engine camshaft.

#### **TIMING CHAIN AND SPROCKETS CLEANING AND INSPECTION**

##### **Cleaning and Inspection Procedure**



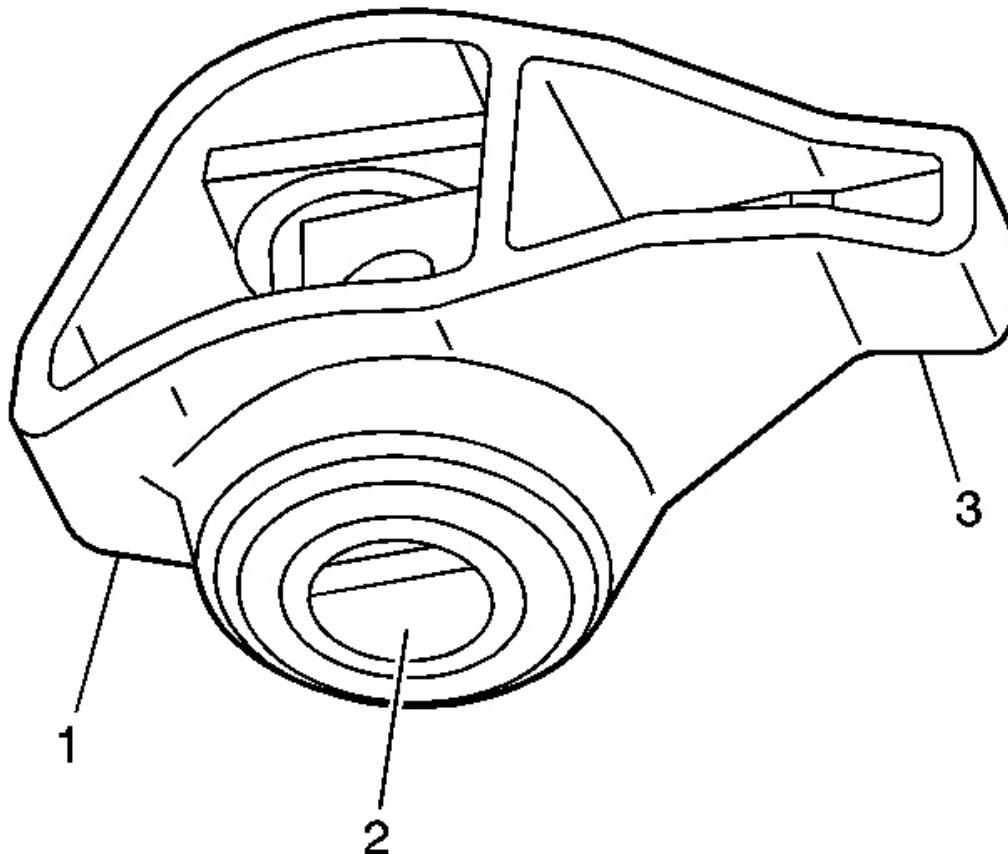
**Fig. 405: Aligning Timing Chain & Sprocket Timing Marks**  
Courtesy of GENERAL MOTORS CORP.

1. Inspect the timing chain and sprockets for damage.
2. Inspect the timing chain for overall in and out movement. Movement should not exceed 25 mm (1 in).

3. Inspect the sprockets for wear.

## VALVE ROCKER ARM AND PUSH ROD CLEANING AND INSPECTION

### Cleaning and Inspection Procedure



**Fig. 406: Cleaning & Inspecting Rocker Arm**  
Courtesy of GENERAL MOTORS CORP.

**CAUTION: Refer to Cleaning Solvent Caution .**

**CAUTION: Refer to Safety Glasses and Compressed Air Caution .**

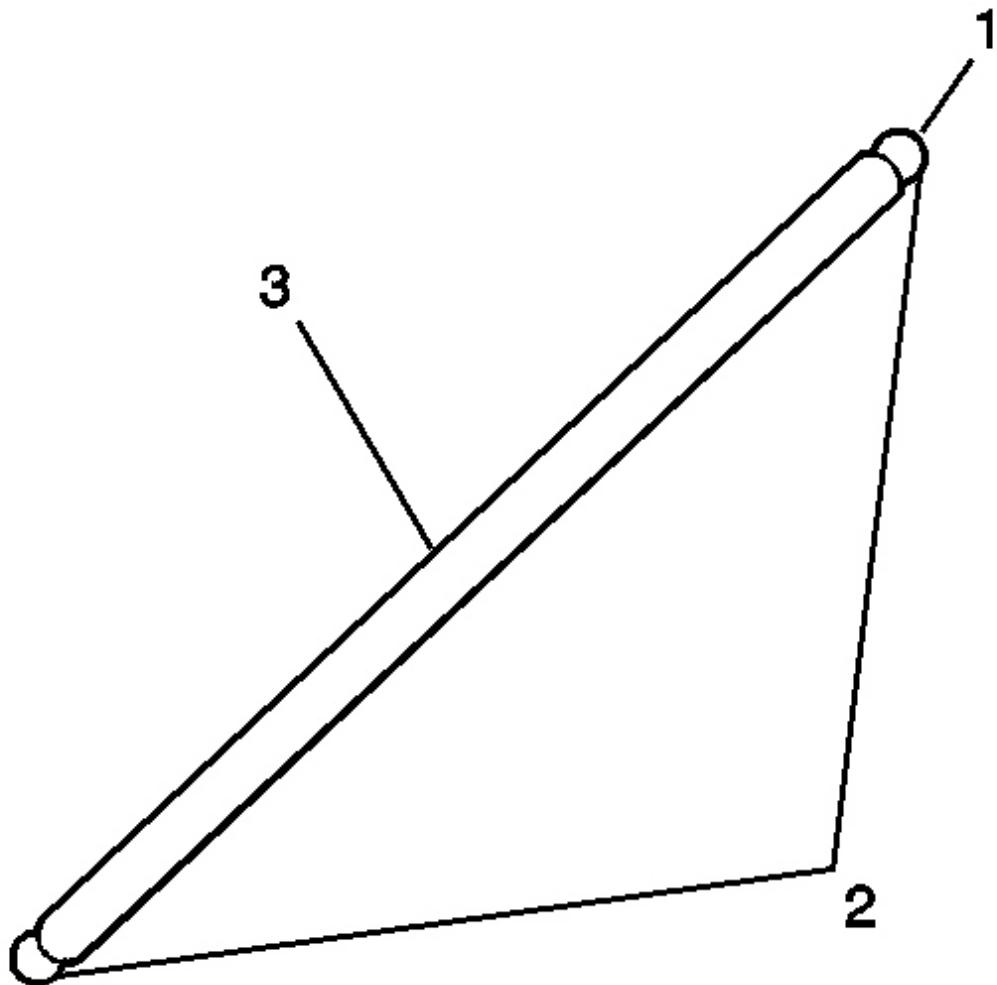
**IMPORTANT: Parts that are to be reused must be marked, sorted and organized for assembly.**

- Clean the components with cleaning solvent.
- Dry the components with compressed air.
- Inspect the valve rocker components for the following:
  - Valve rocker arm valve pushrod socket contact surface (1)

The contact surface must be smooth with no scoring or excessive wear.

- Valve rocker arm roller pivot for binding or damage (2)
- Valve rocker arm valve stem contact surface (3)

The contact surface should be smooth with no scoring or excessive wear.



**Fig. 407: Identifying Pushrod Inspection Areas**  
Courtesy of GENERAL MOTORS CORP.

- Inspect the valve pushrods for the following:
  - Restriction of the oil passage (1)
  - Wear or scoring of the end contact surfaces (2)

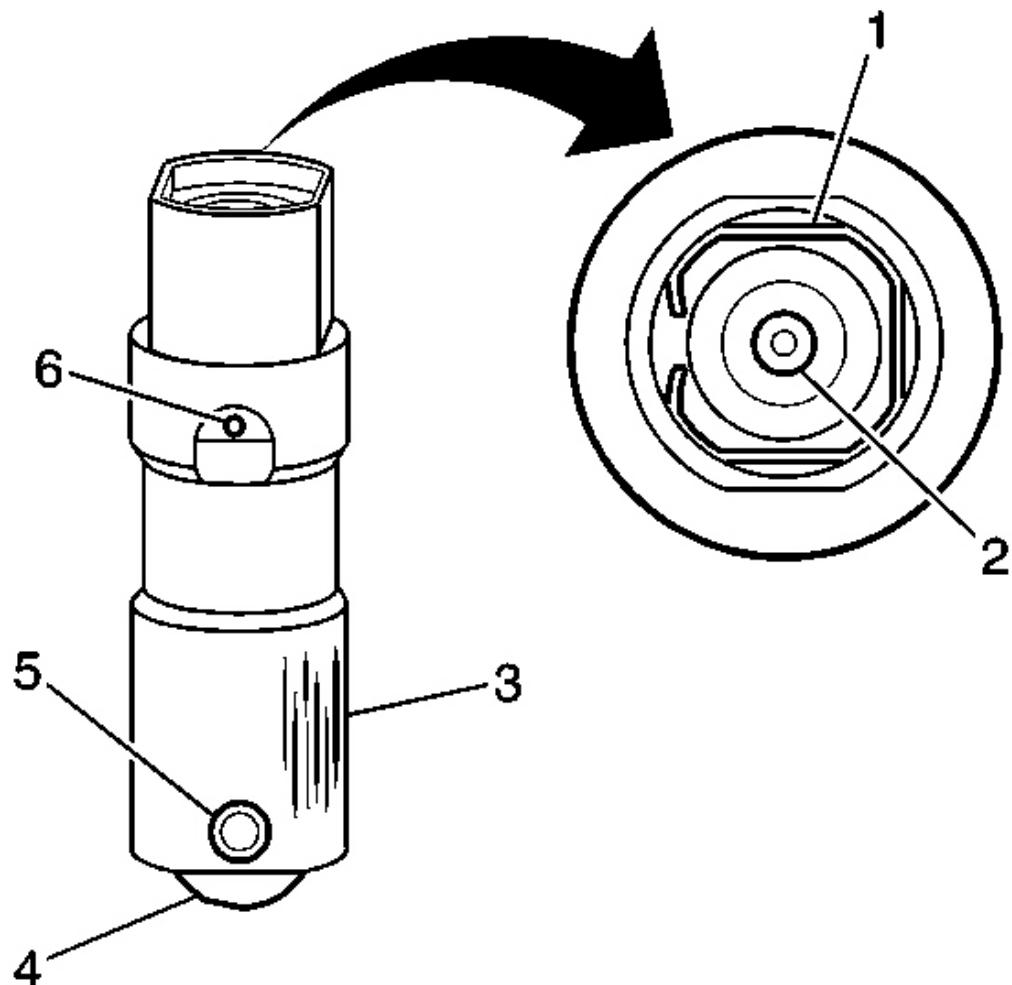
The end contact surfaces must be smooth with no scoring or excessive wear.

- Shaft for bends (3)

Roll the valve pushrod on a flat surface to determine if the valve pushrod is bent.

## VALVE LIFTERS AND GUIDES CLEANING AND INSPECTION

### Cleaning and Inspection Procedure



**Fig. 408: Inspecting Areas Of Valve Lifters**

Courtesy of GENERAL MOTORS CORP.

1. Keep the valve lifters in order so they can be installed in their original position.

**IMPORTANT: When new valve lifters are installed, coat the valve lifters with camshaft and lifter prelube GM P/N United States 12345501, GM P/N Canada 992704 or the equivalent.**

2. Inspect the following areas of the valve lifters:

- The retaining clip (1)
- The push rod socket for wear (2)
- The valve lifter body for wear and scuffing (3)
- The valve lifter bore for wear
- The valve lifter roller assembly for wear (4)
- The valve lifter roller pin for damage (5)
- The oil hole for plugging (6)

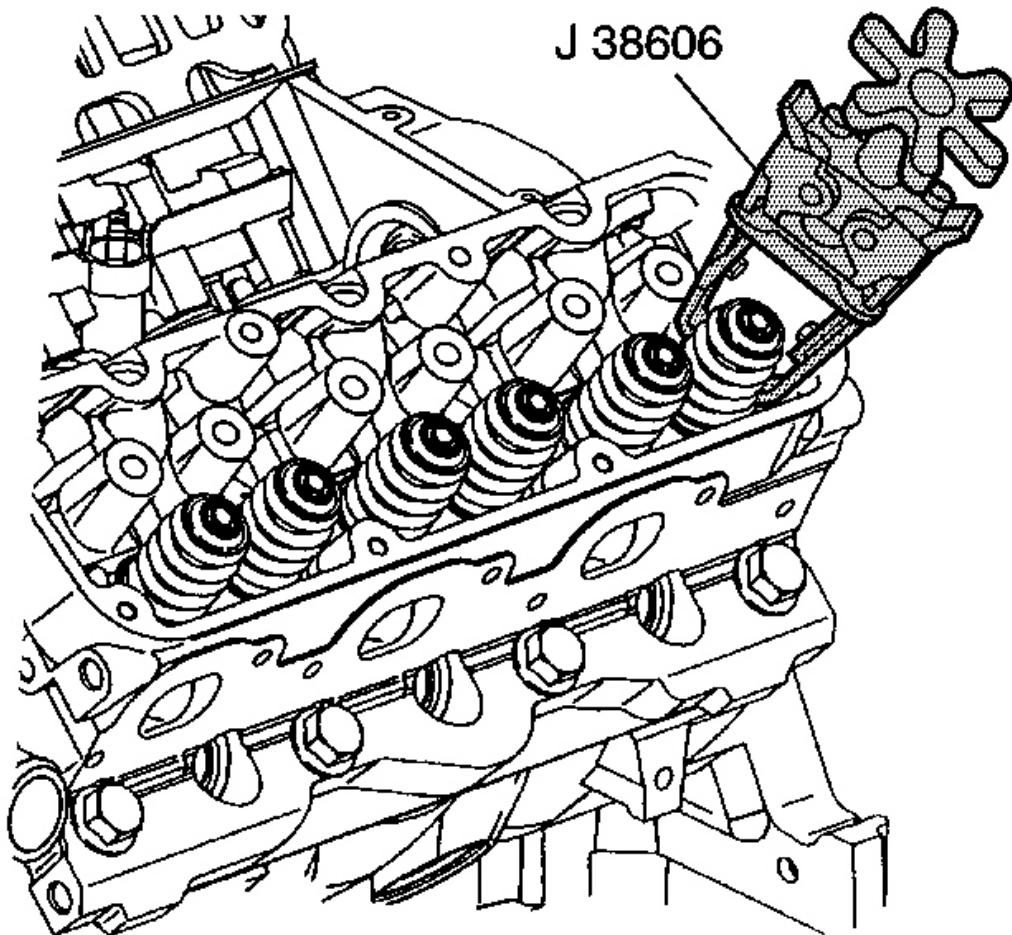
3. Inspect the valve lifter guides for cracks or damage.

## CYLINDER HEAD DISASSEMBLE

### Tools Required

**J 38606** Valve Spring Compressor

### Disassembly Procedure

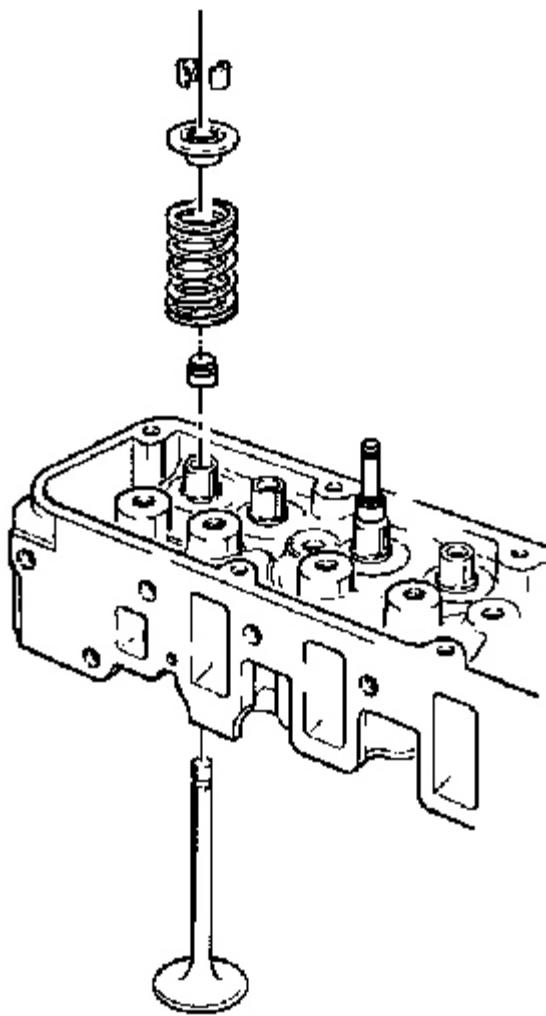


**Fig. 409: Compressing Valve Spring**

Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** During disassembly, ensure the valve train components are kept together and identified so they can be reinstalled in their original locations and with the same mating surfaces as when removed.

1. Use **J 38606** to compress the valve spring.



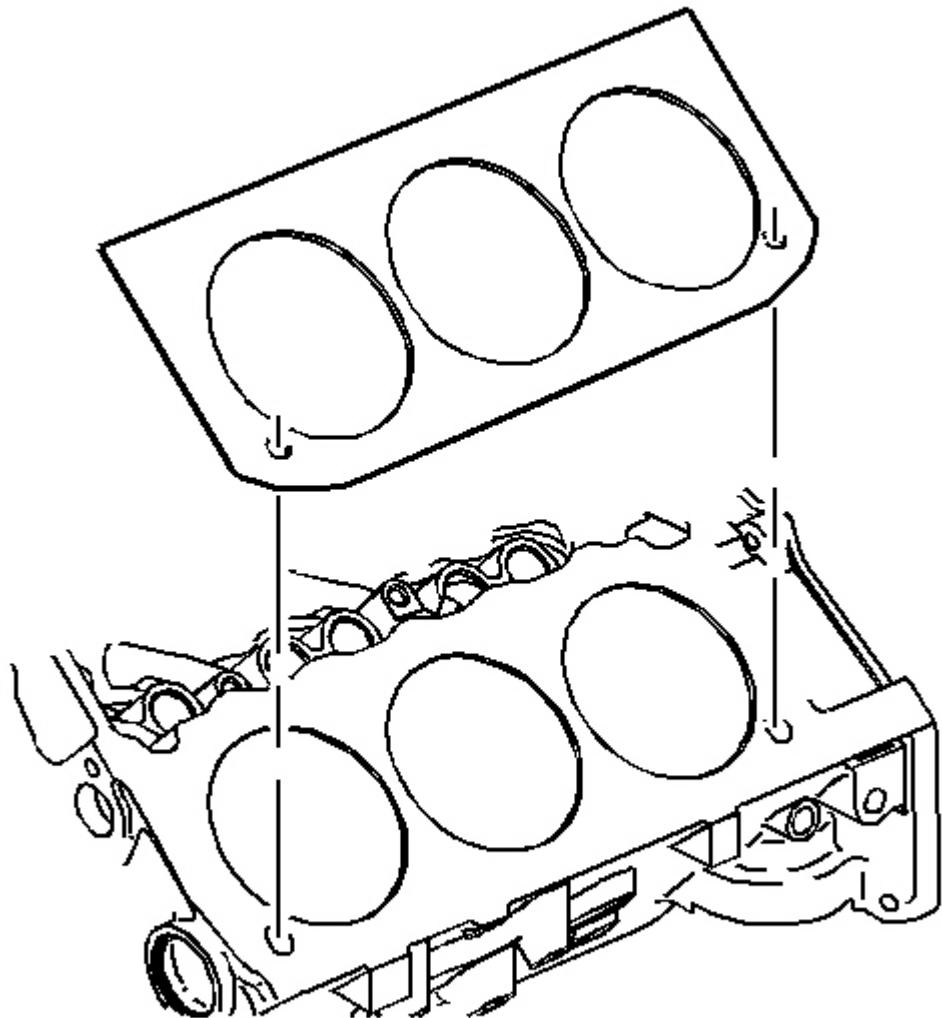
**Fig. 410: Identifying Valve Components**  
Courtesy of GENERAL MOTORS CORP.

2. Remove the valve keys.
3. Remove the valve cap and spring.
4. Remove the valve stem oil seal by prying up on the bottom.

**Tools Required**

**J 9666** Valve Spring Tester

**Cleaning and Inspection Procedure**



**Fig. 411: View Of Cylinder Head Gasket**

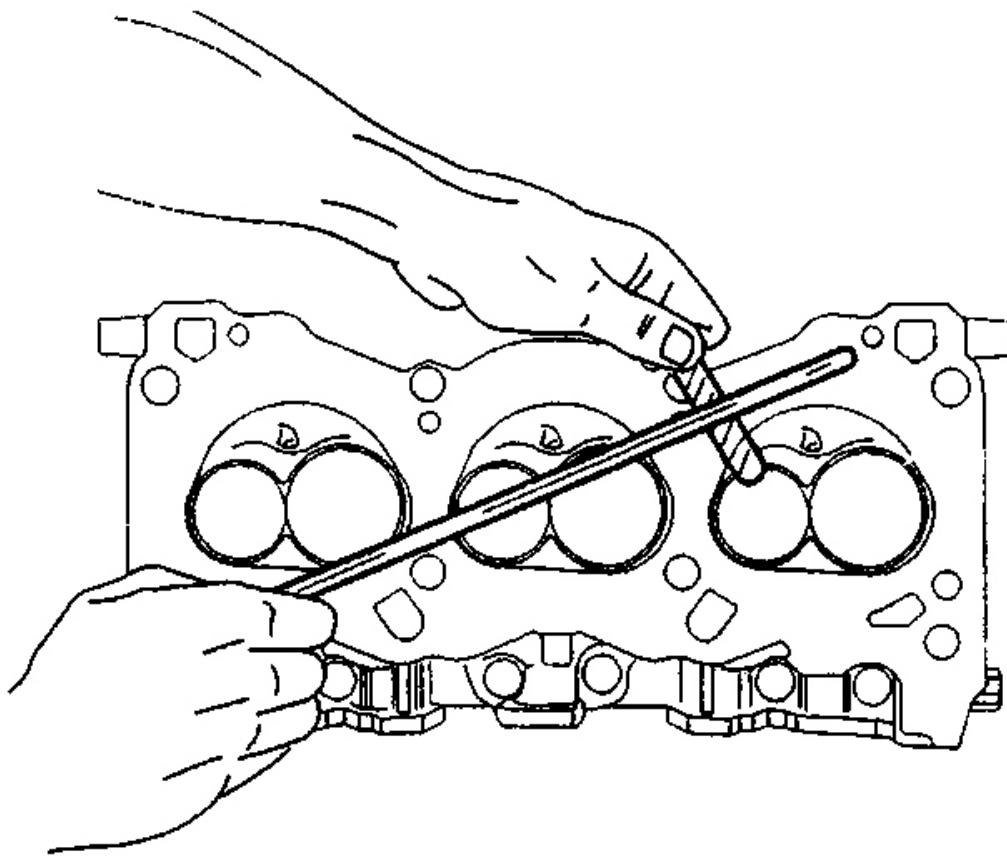
Courtesy of GENERAL MOTORS CORP.

1. Inspect the cylinder head gasket and the mating surfaces for leaks, corrosion and blowby.

2. If the gasket failed, determine the cause. Gasket failure is caused by the following conditions:
  - Improper installation
  - A loose or warped cylinder head
  - Missing dowel pins
3. Clean the cylinder head of all foreign material. Do not use a motorized wire brush on any gasket sealing surface.
4. Clean the threaded holes.
5. Inspect the cylinder head for cracks typically between the valve seats and inside of the exhaust ports.

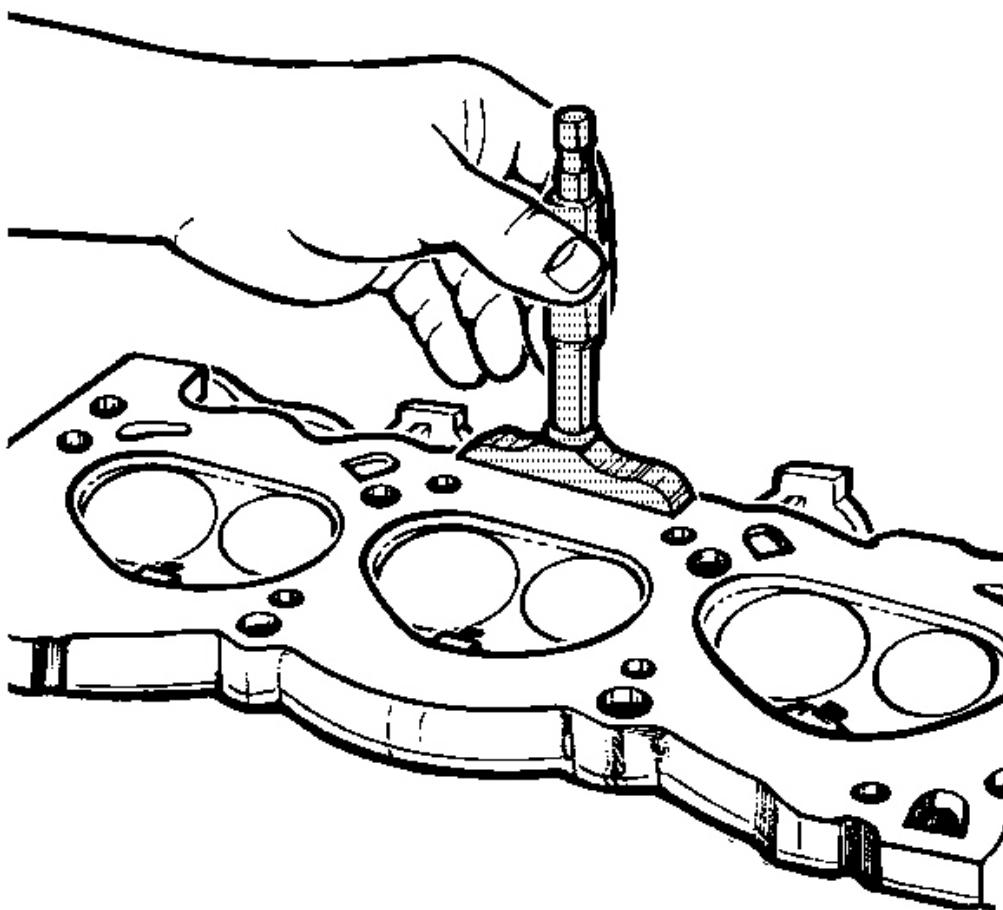
**IMPORTANT: Do not attempt to weld the cylinder head. If the cylinder head is damaged, replace the cylinder head.**

6. Inspect the cylinder head deck for corrosion.



**Fig. 412: Inspecting Cylinder Head Mating Surfaces For Flatness**  
Courtesy of GENERAL MOTORS CORP.

7. Inspect the following locations for flatness:
  - The cylinder head deck
  - The intake manifold mating surface
  - The exhaust manifold mating surface
8. Recondition the surfaces by parallel grinding. Replace the cylinder head if more than 0.254 mm (0.010 in) is removed.



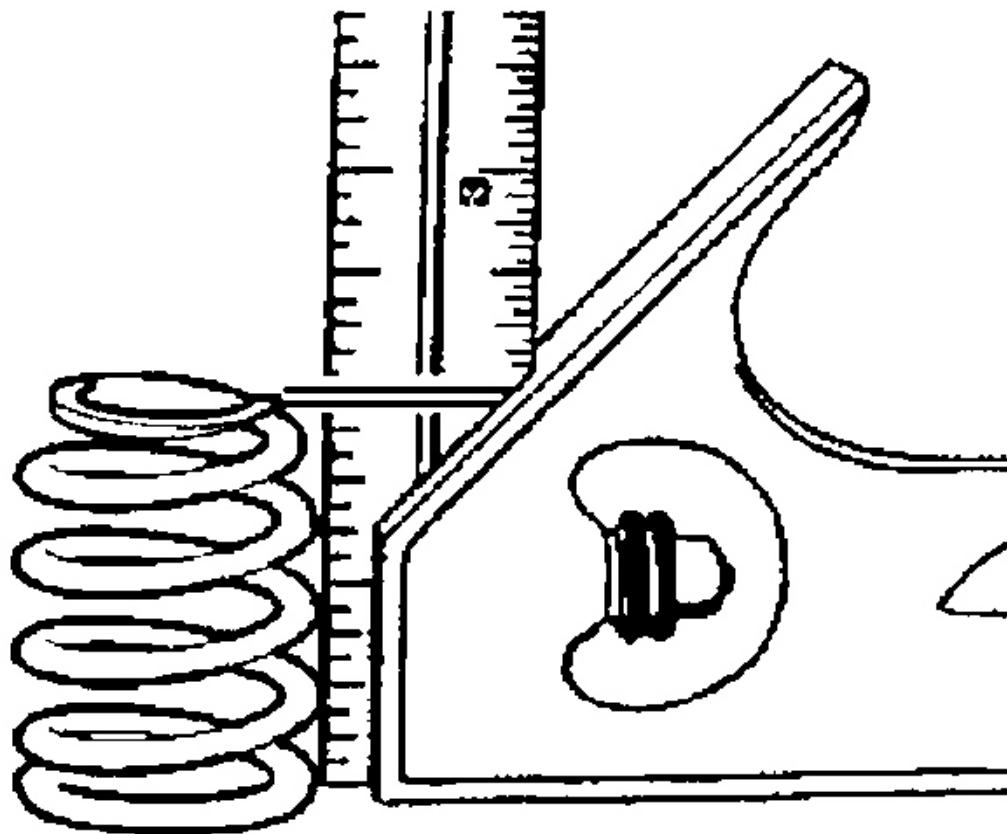
**Fig. 413: Measuring Cylinder Head Height From deck Surface To Cast Pads**  
Courtesy of GENERAL MOTORS CORP.

9. Measure the height from the deck surface to the cast pads. Do this to determine if the cylinder head has sufficient deck surface thickness to resurface.

New cylinder heads measure from 1.372-1.676 mm (0.054-0.066 in). If the cylinder head does not meet the minimum thickness after resurfacing, replace the cylinder head.

10. Inspect all of the threaded holes for damage. Repair the threaded holes, if necessary.
11. Inspect the valve seating surfaces.
12. Inspect the cooling jacket plugs.

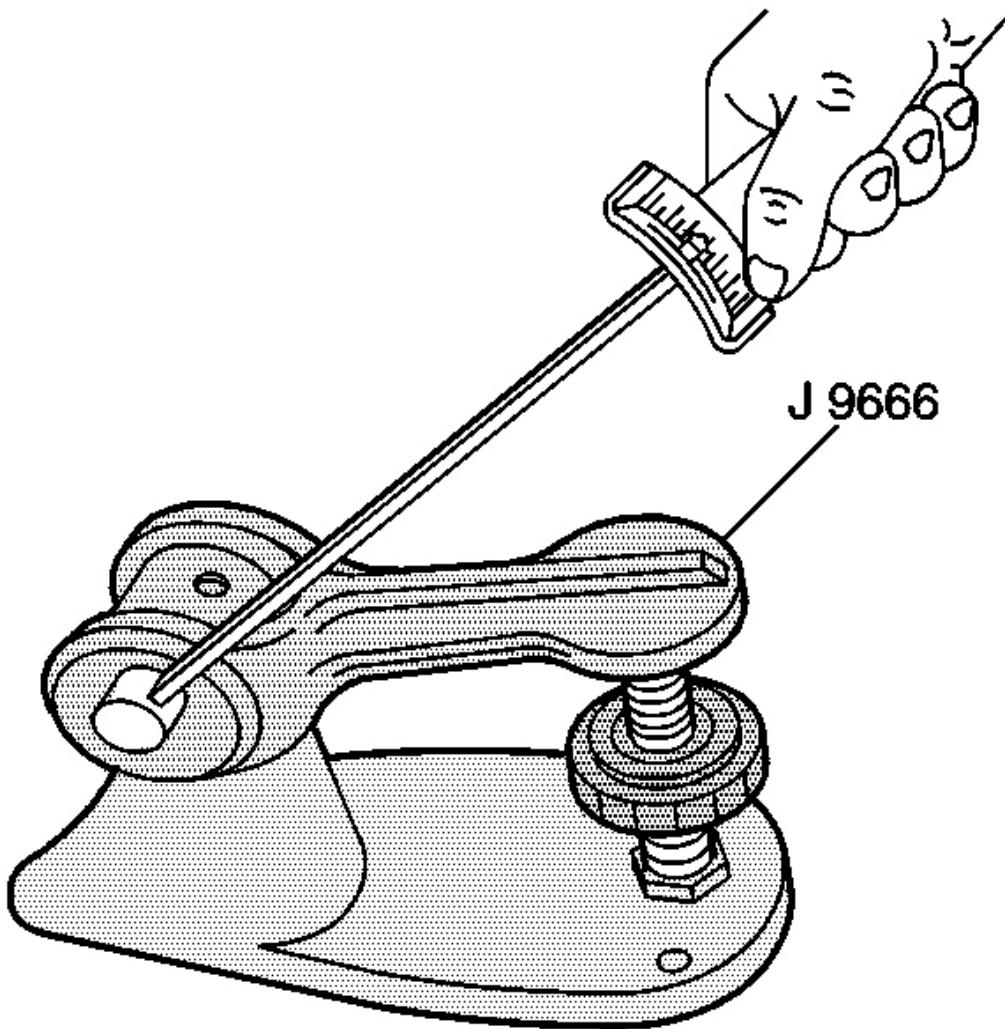
13. Inspect the valve guides for wear. Clean the valve guides.
14. Inspect the valve seats for excessive wear and hot spots.



**Fig. 414: Measuring Valve Springs For Squareness**

Courtesy of GENERAL MOTORS CORP.

15. Inspect the valve springs for squareness.
16. Inspect the valve spring ends. If the valve spring ends are not parallel, the valve spring is bent. Replace the bent valve spring.



**Fig. 415: Measuring Valve Spring Tension**

Courtesy of GENERAL MOTORS CORP.

17. Using the **J 9666** test the valve spring load. Replace the spring if the valve spring load is less than 334 N.m at 43.69 mm (75 lb at 1.72 in).
18. Inspect the valve spring seating surface of the valve spring retainers for wear or gouging. If the seating surface is damaged, replace the valve spring retainers.
19. Use the following procedure to measure the valve seat concentricity:
  1. Lift the valve off its seat.

2. Apply a dab of blue dye to the valve face.
3. Seat and rotate the valve.

The blue dye traces transferred to the valve seat are an indication of concentricity of the valve seat.

20. Use the following procedure to measure the valve runout:

1. Clean off the blue dye.
2. Apply blue dye to the valve seat.
3. Seat and rotate the valve.

The traces of blue dye transferred to the valve indicates valve runout.

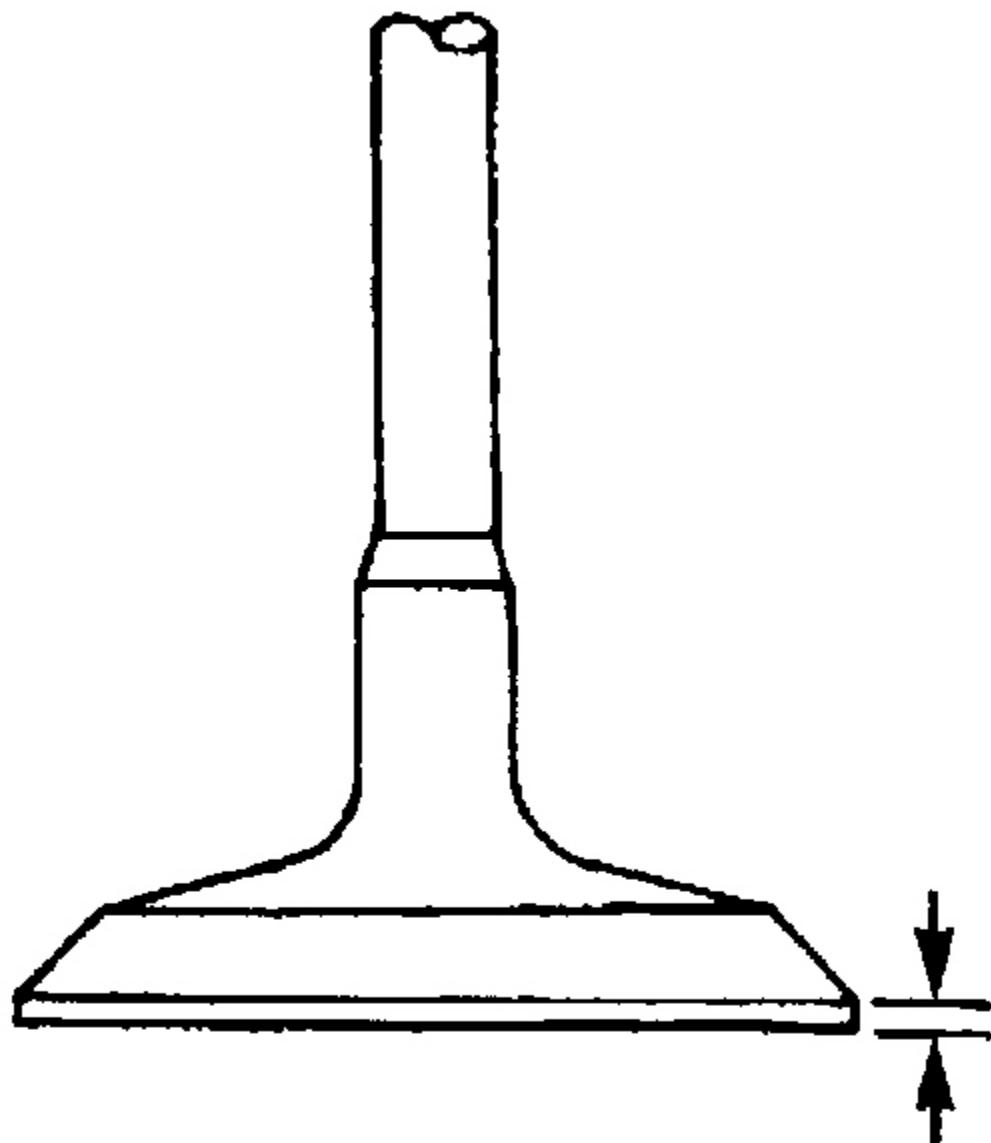
4. Recondition the valve seat or valve face, if needed.

## **VALVE GUIDE REAMING/VALVE AND SEAT GRINDING**

### **Tools Required**

**J 8001** Dial Indicator Set. See **Special Tools**.

### **Procedure**



**Fig. 416: Inspecting Valve Margin**

Courtesy of GENERAL MOTORS CORP.

1. Recondition the valve seats by grinding. Use an oscillating type valve seat grinder. Follow the grinder manufacturer's instructions. If the valve seat is too wide after grinding, use a 20 degree stone or a 70 degree stone in order to narrow the valve seat. The 20 degree stone

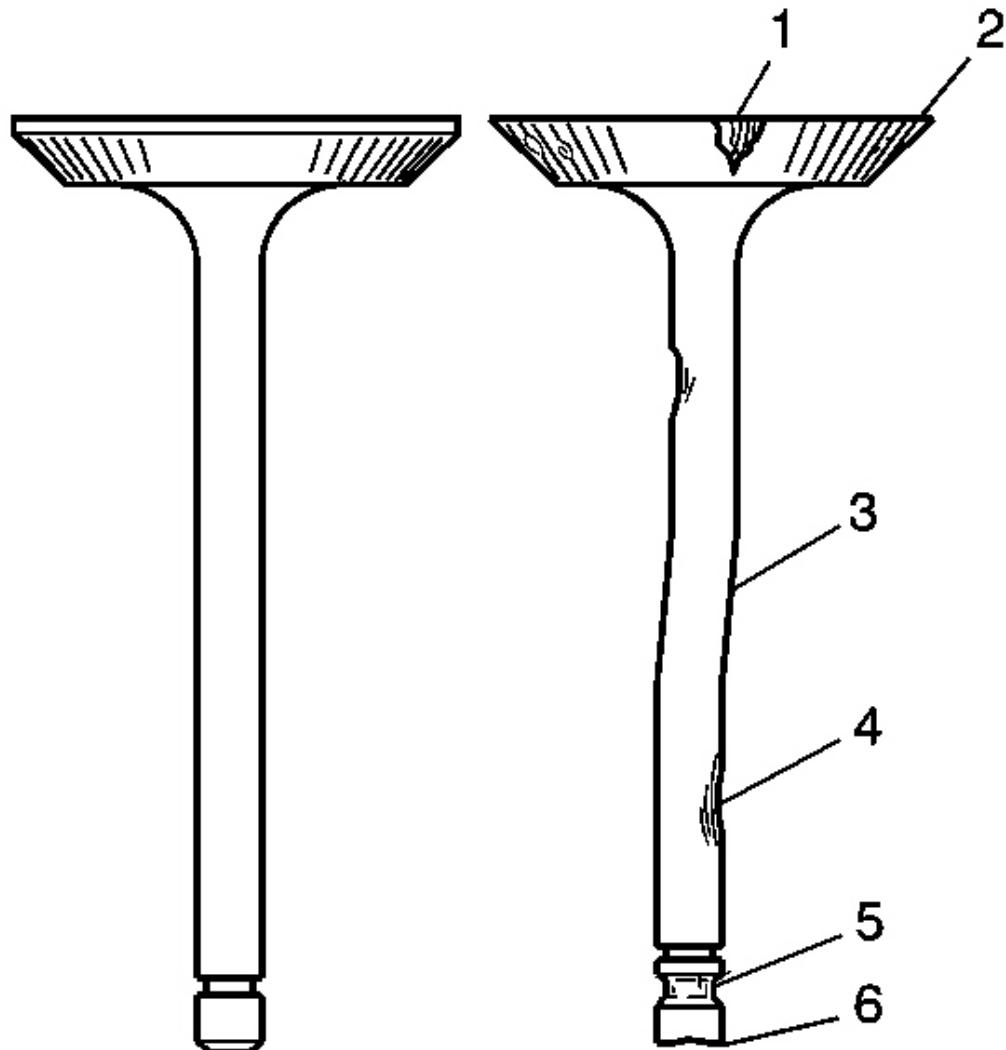
will lower the seat. The 70 degree stone will raise the seat. Replace or recondition the valves if the seats are reconditioned.

2. After grinding the valves, measure the valve margin. Replace the valve if less than the minimum recommended specification (0.79 mm (0.031 in).

**CAUTION: Refer to Cleaning Solvent Caution .**

**NOTE: Clean the valve guides before reaming. Packing of chips or carbon may result in the reamer jamming into the valve guide or broken reamer flutes.**

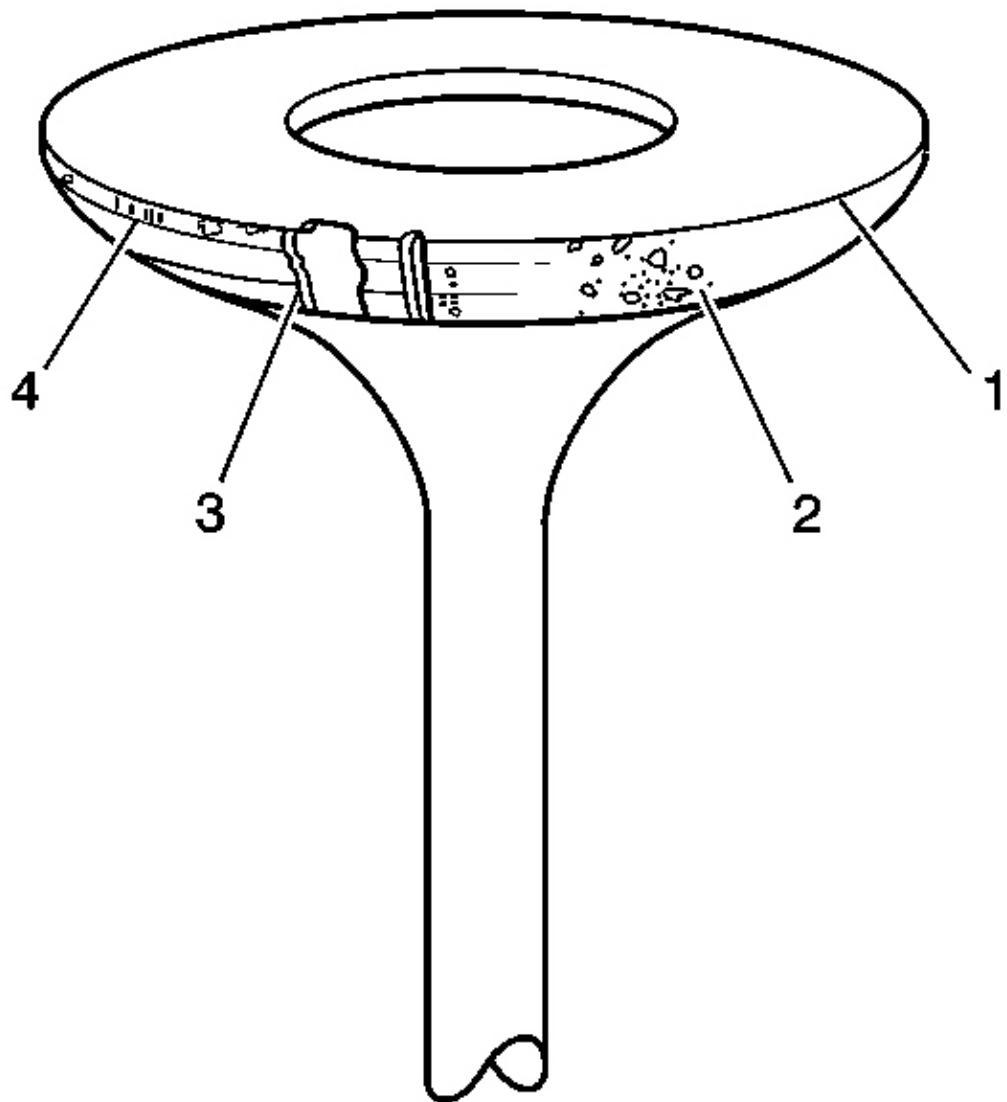
3. Clean any foreign material from the valves. Use a wire brush to remove carbon. Do not scratch the valve stem. Soak the valves in cleaning solvent to remove varnish.
4. Use a suitable tool to clean the valve guides.
5. Follow the grinder manufacturer's instructions. Ensure that the new surface is perpendicular to the valve stem.



**Fig. 417: Identifying Inspection Points For Valves Damage**  
Courtesy of GENERAL MOTORS CORP.

6. Inspect the valve key grooves for chipped or worn lands (5). Replace the valve if the valve key groove is damaged.
7. Inspect the valve stem tip for wear (6). Recondition the valve stem tip by grinding.
8. Inspect the valve stem for burrs and scratches (4). Use an oil stone to remove burrs and minor scratches.

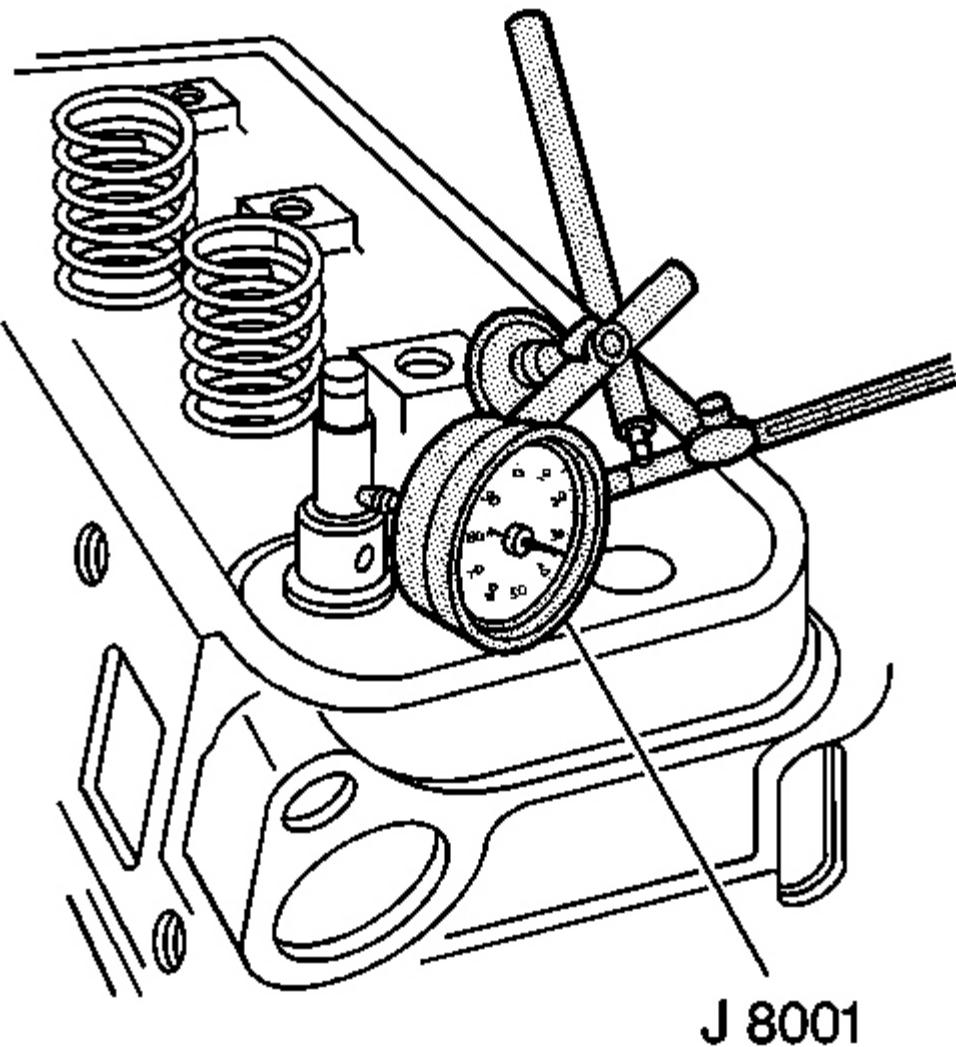
9. Inspect the valve stem for straightness (3). Use V blocks to inspect the valve head for bending or distortion. Replace any bent or distorted valves.
10. Inspect the valve face for grooving (1, 2). If the groove is so deep that refacing the valve face would result in a knife edge, replace the valve.



**Fig. 418: Inspecting Valve Face For Burning, Pitting & Cracking**

Courtesy of GENERAL MOTORS CORP.

11. Inspect the valve face for burning, pitting or cracking (1, 2, 3, 4). If pieces of the valve face are broken off, replace the valve and inspect the corresponding piston and cylinder head area for damage.



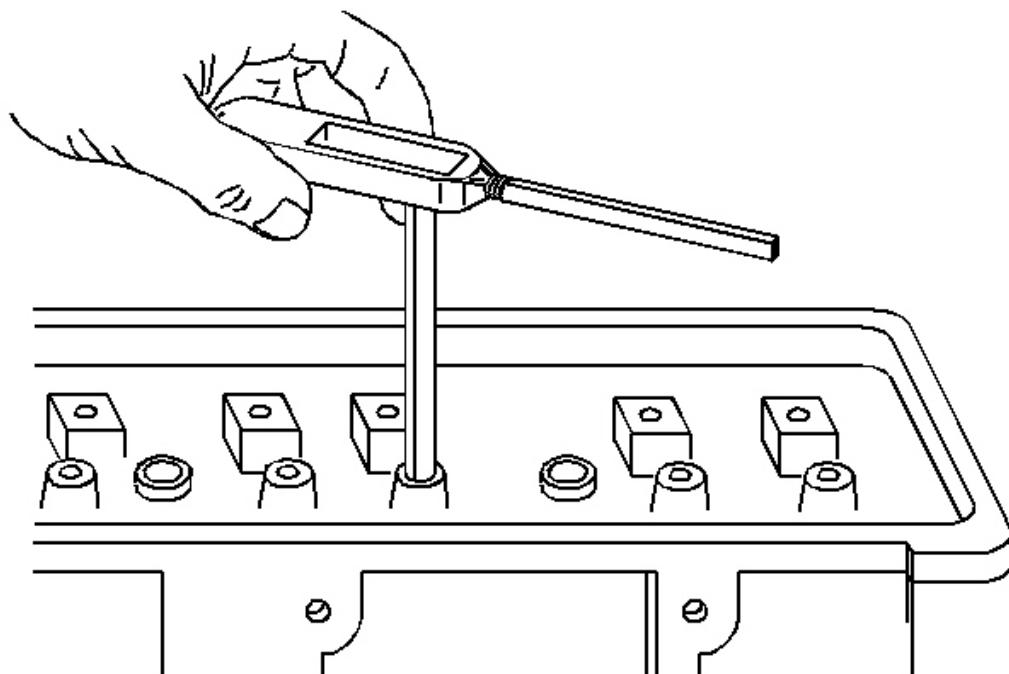
**Fig. 419: Measuring Valve Stem Clearance**  
Courtesy of GENERAL MOTORS CORP.

12. Measure the valve stem clearance:

1. Insert the valve into the guide.
2. Lift the valve 2 mm (1/8 in) off of the seat.
3. Move the valve from side to side.
4. Use **J 8001** to measure the amount of movement. See **Special Tools**.

The intake valve stem clearance should be between 0.031-0.071 mm (0.0012-0.0028 in).

The exhaust valve stem clearance should be between 0.036-0.074 mm (0.0014-0.0029 in).

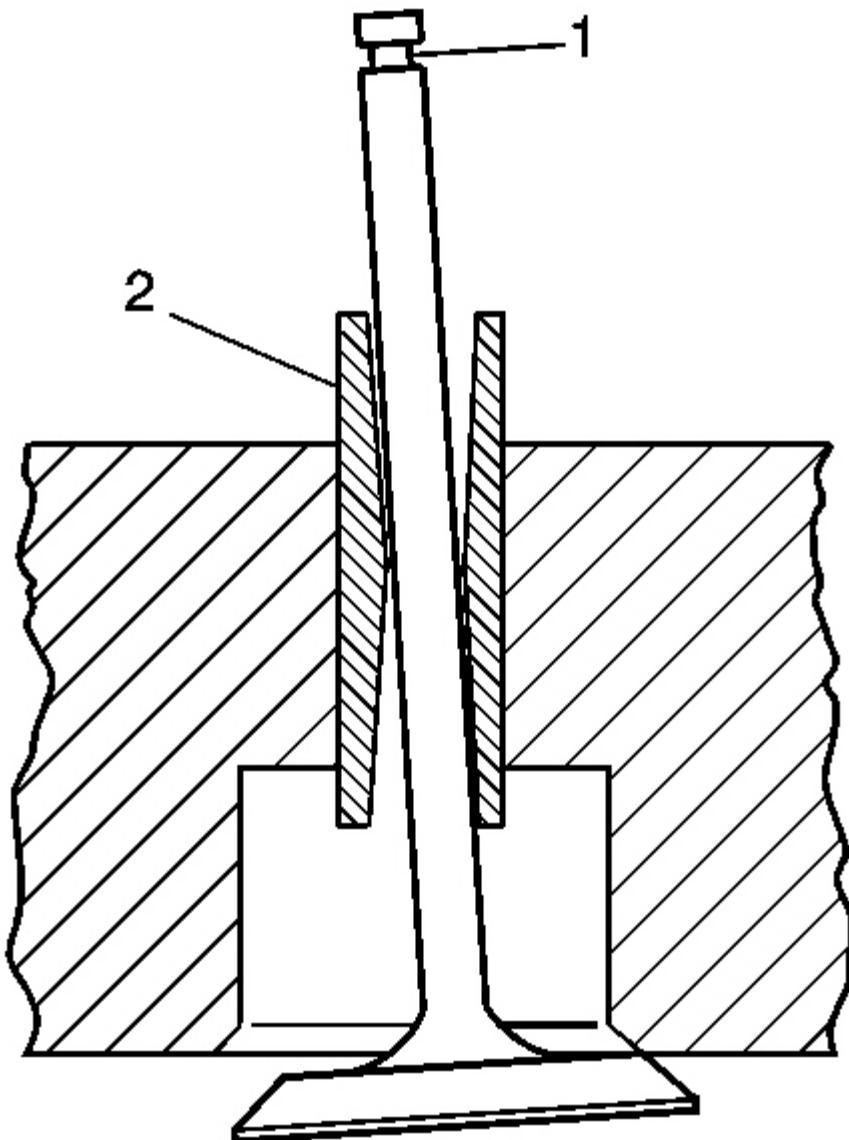


**Fig. 420: Reaming Valve Guides For Oversize Valves**

Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** Clean the valve guide before reaming to avoid breaking the reamer flutes. Do not push down on the reamer.

13. Ream the valve guides for oversize valves if the clearance exceeds the specifications.
14. Ream the valve guide bores for the oversize valves.
15. Recondition the valve seats after reaming the valve guide bores or installing the new valve guides.



**Fig. 421: Inspecting For Excessive Valve Stem To Guide Clearance**  
Courtesy of GENERAL MOTORS CORP.

16. Inspect the valve stem for straightness. Use V blocks to inspect the valve head for bending or distortion. Replace any bent or distorted valves.

- It is essential that the valve guide bores are free of carbon or dirt to ensure the proper centering of the pilot in the guide.

The valve seats should be concentric to within 0.05 mm (0.031 in) total indicator reading.

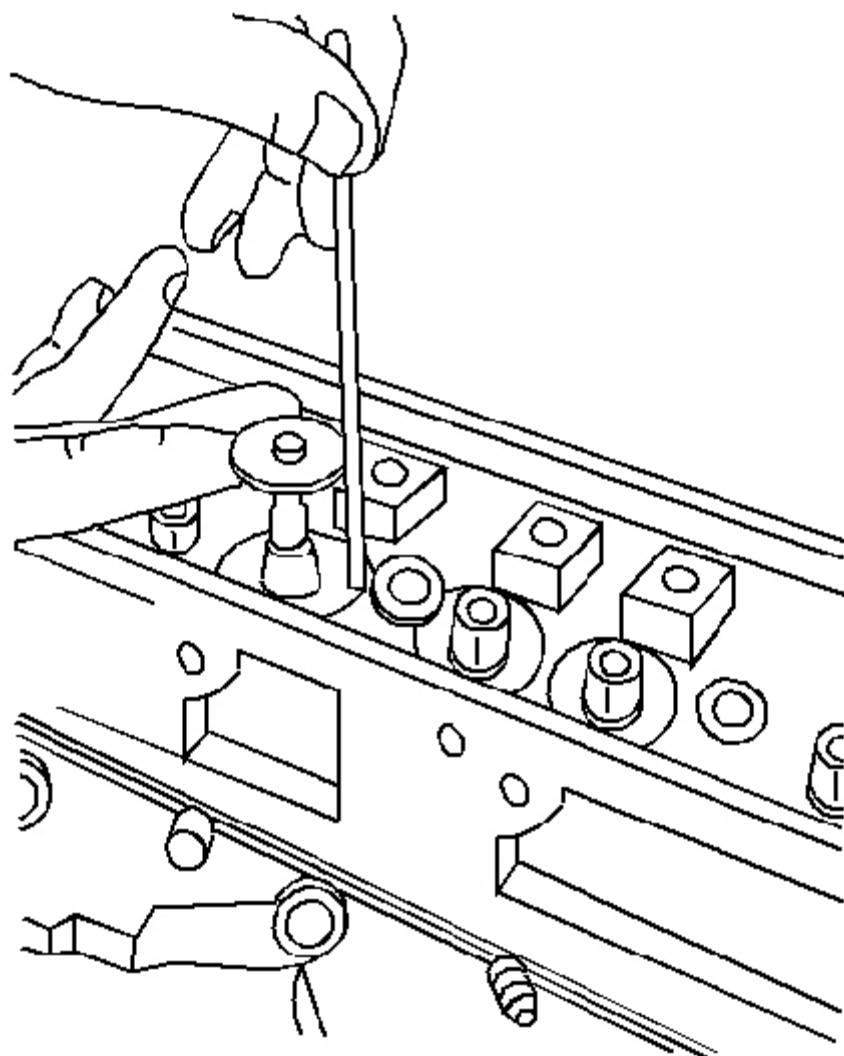
- Reface pitted valves on a valve refacing machine to ensure the correct relationship between the valve head and the valve stem.
- Replace the valve if the valve stem is warped (2) or if the valve stem shows signs of excessive wear.
- Inspect the valve key area (1) for damage and carbon build up.
- Replace the valve if the edge of the head is less than 0.79 mm (0.031 in) thick after grinding.
- Use the manufacturer's recommendations of equipment for the proper results.

## CYLINDER HEAD ASSEMBLE

### Tools Required

- **J 38606** Valve Spring Compressor. See [Special Tools](#).
- **J 42863** Valve Seal Installer. See [Special Tools](#).

### Assembly Procedure



**Fig. 422: Measuring Valve Stem Height**  
Courtesy of GENERAL MOTORS CORP.

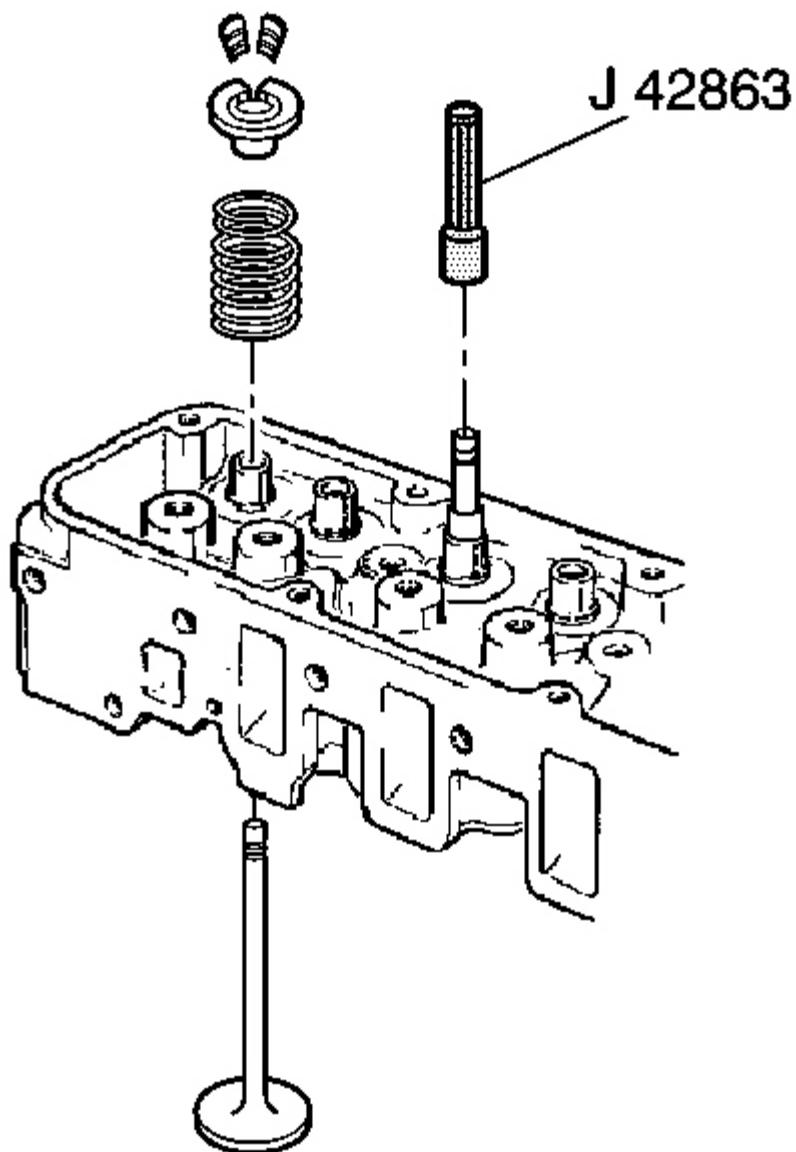
1. Install the valves. The valves are available in standard size and 0.381 mm (0.015 in) oversize. Use oversize valve seals if oversized valves are used.
2. Use the following procedure to measure the valve stem height:
  1. Place the valve on the guide. Hold the valve in the closed position.

2. Use a valve stem height gauge to measure the valve stem height.
3. The measurement should be 49-50 mm (1.93-1.97 in).

**NOTE: Use hand pressure only when installing the valve seal using J 42863. Using too much force may cause damage to the oil seal and possibly lead to excessive oil consumption.**

3. Use the following procedure to measure the valve spring installed height:
  1. Place the valve in the valve guide.
  2. Install the valve spring cap and the valve cap keys.
  3. Seat the valve spring retainer by pulling up.
  4. Use a steel machinists' rule to measure the distance from the spring seat to the bottom of the valve spring cap.
  5. The measurement should be 42-44 mm (1.69-1.75 in).

If the measurement is not within specifications add shims under the valve spring.

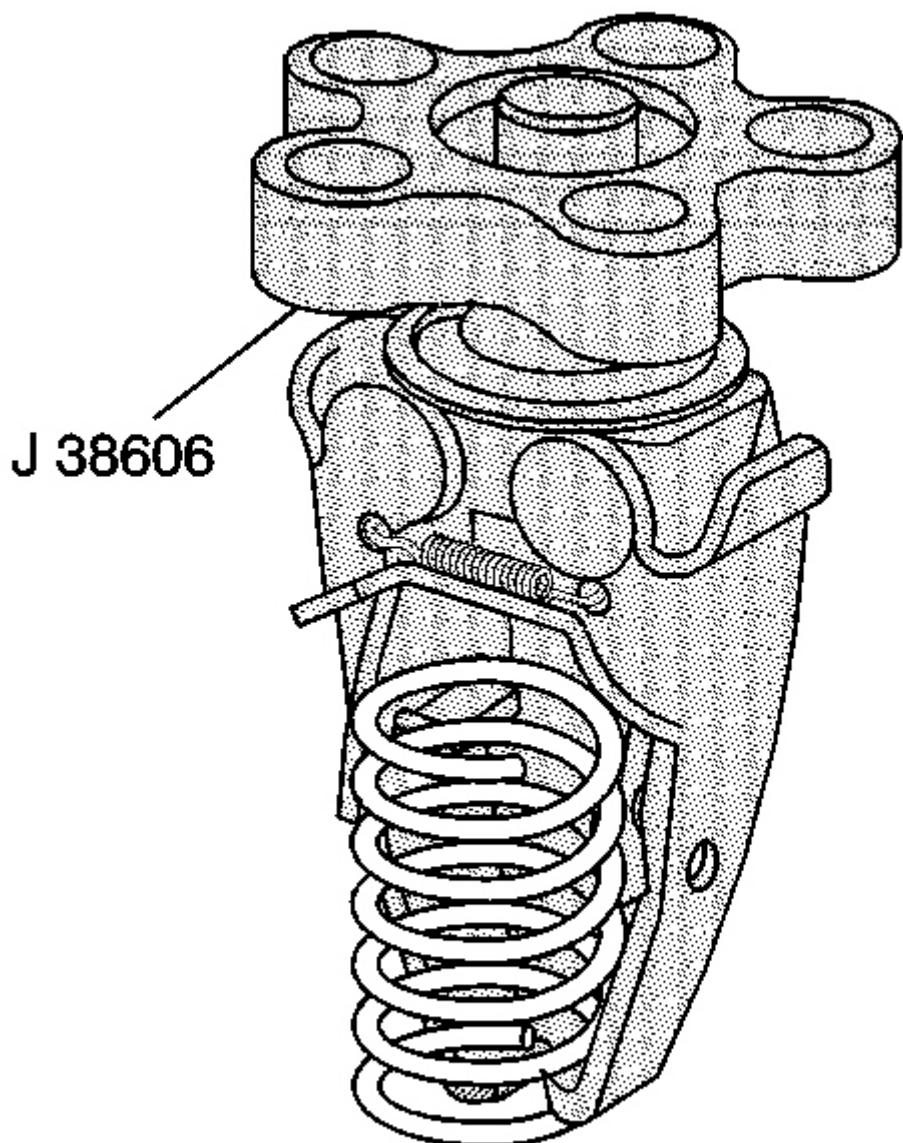


**Fig. 423: Installing Valve Stem Oil Seal**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT: Use hand pressure only when installing the valve seal using J 42863 . See Special Tools. Using to much force may cause**

**damage to the oil seal and possibly lead to excessive oil consumption.**

4. Place the valve stem oil seal over the valve stem so the seal begins to contact the valve guide.
5. Use **J 42863** to push the valve stem oil seal over the valve guide. See **Special Tools**.

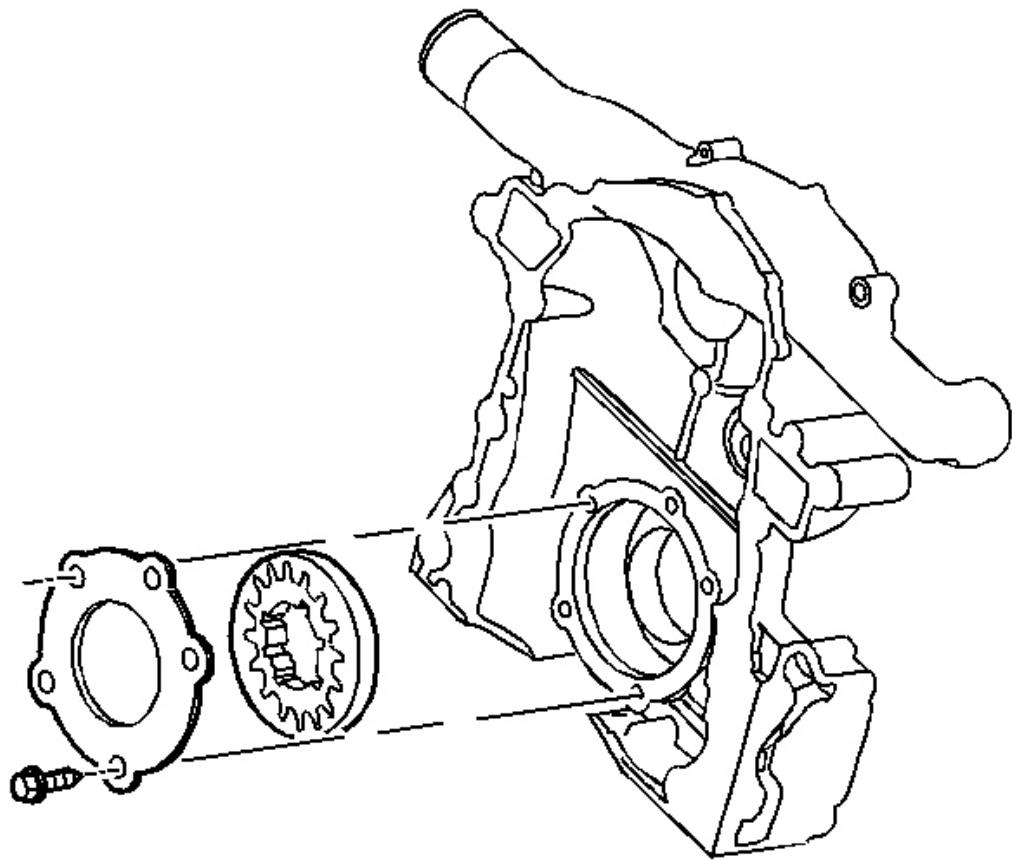


**Fig. 424: Installing Valve Spring**  
Courtesy of GENERAL MOTORS CORP.

6. Use **J 38606** to install the valve spring and the valve cap. See [Special Tools](#).
7. Install the valve keys.

## OIL PUMP DISASSEMBLE

### Disassembly Procedure

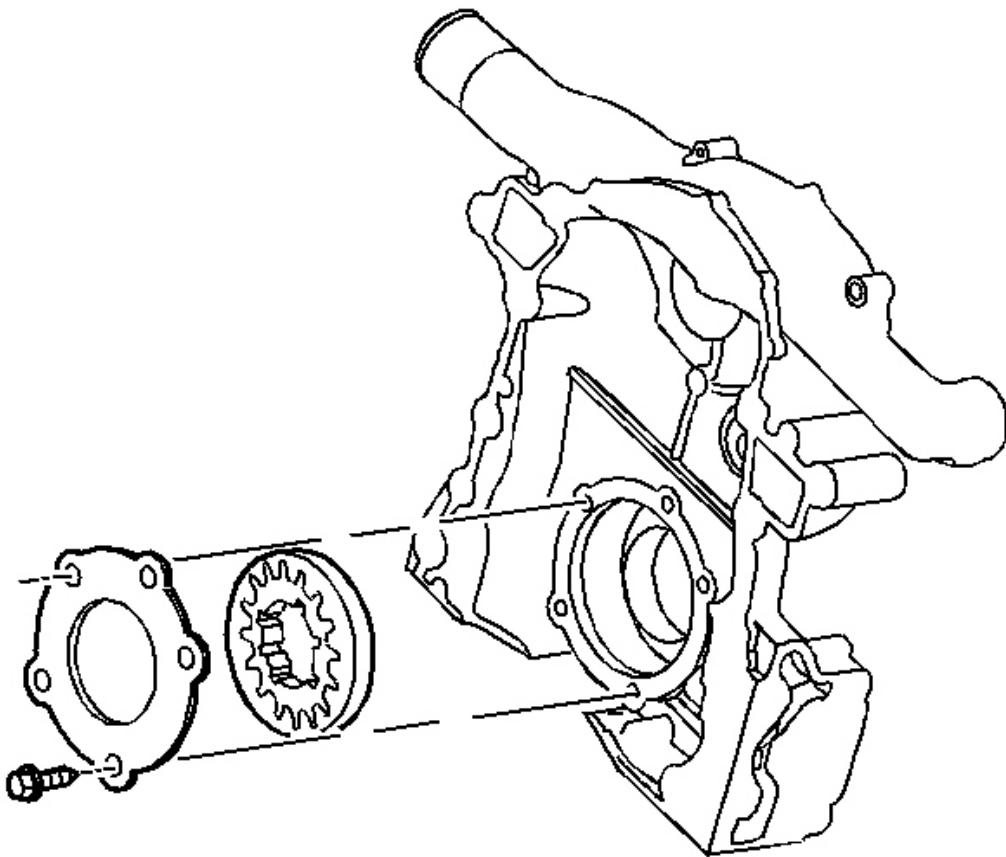


**Fig. 425: Exploded View Of Oil Pump Components**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil pump cover screws.
2. Remove the oil pump cover.
3. Remove the oil pump gears.

## OIL PUMP CLEANING AND INSPECTION

### Cleaning and Inspection Procedure



**Fig. 426: Exploded View Of Oil Pump Components**  
Courtesy of GENERAL MOTORS CORP.

**CAUTION: Refer to Cleaning Solvent Caution .**

1. Use a suitable solvent to clean the oil pump.
2. Remove all old gasket material from the engine front cover and from the engine block.
3. Inspect the oil pump cover and the engine front cover for the following damage:
  - Cracks
  - Scoring
  - Porous or damaged casting

## 2006 Buick Lucerne CXS

### 2006 ENGINE Engine Mechanical - 3.8L - Lucerne

- Damaged threads
- Excessive wear

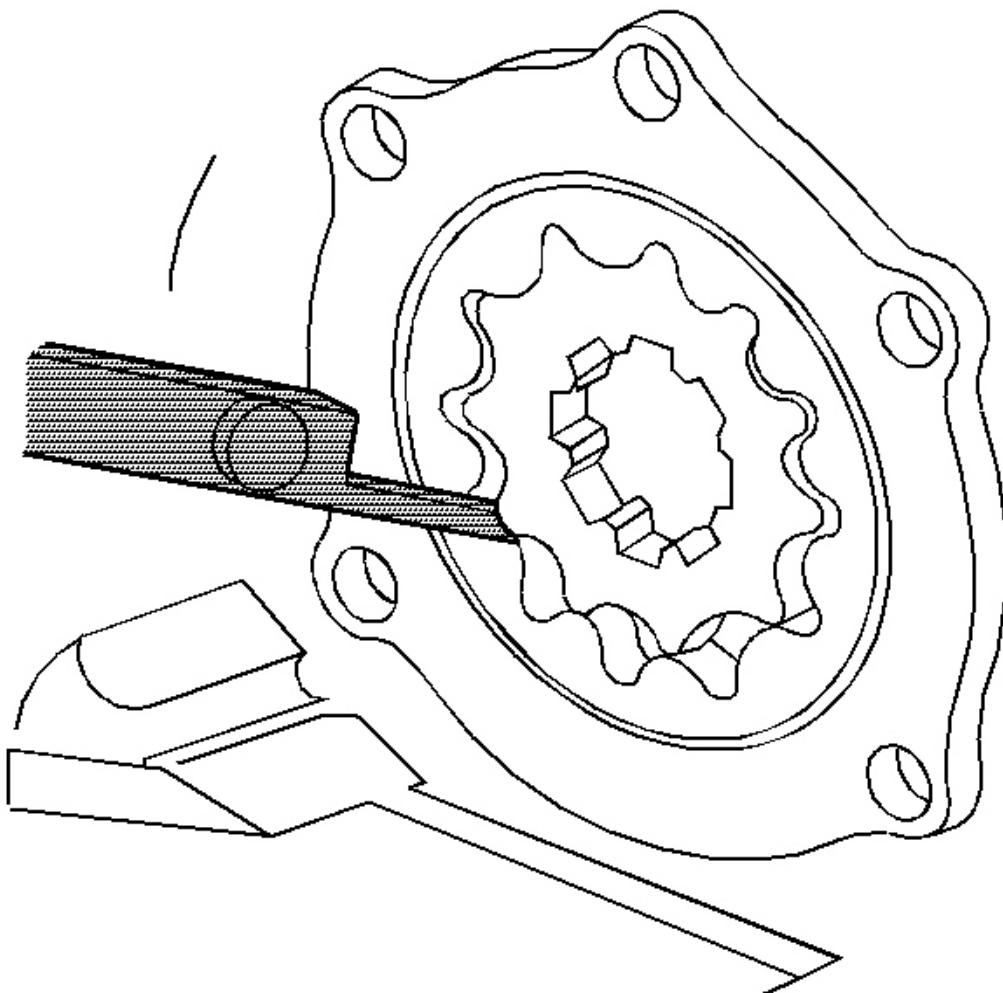
4. Inspect the pressure regulator valve for the following damage:

- Scoring
- Sticking in the bore
- Burrs
- Foreign material

5. Inspect the pressure regulator spring for loss of tension or bending. Replace the pressure regulator spring if damaged.

6. Inspect the oil pump gears for the following conditions:

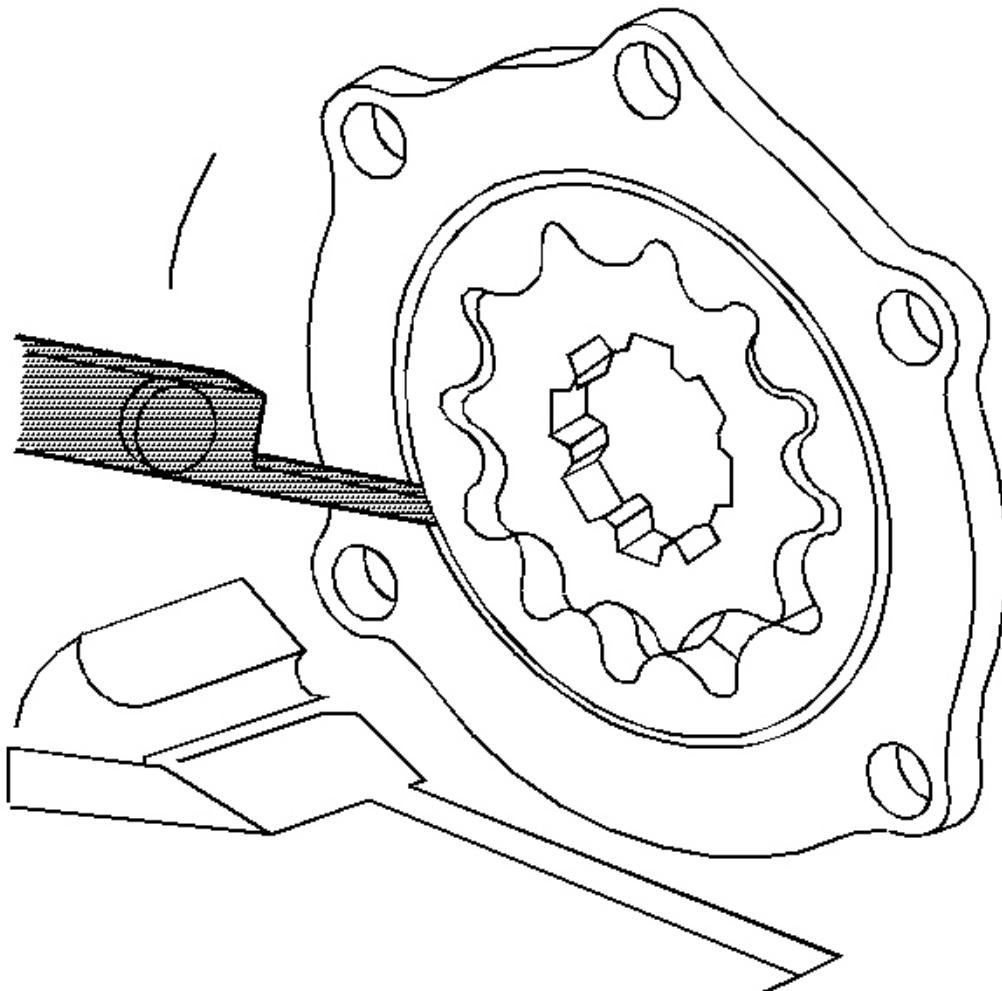
- Chipping
- Galling
- Scoring
- Excessive wear



**Fig. 427: Measuring Inner Oil Pump Gear Tip Clearance**  
Courtesy of GENERAL MOTORS CORP.

7. Measure the inner oil pump gear tip clearance.

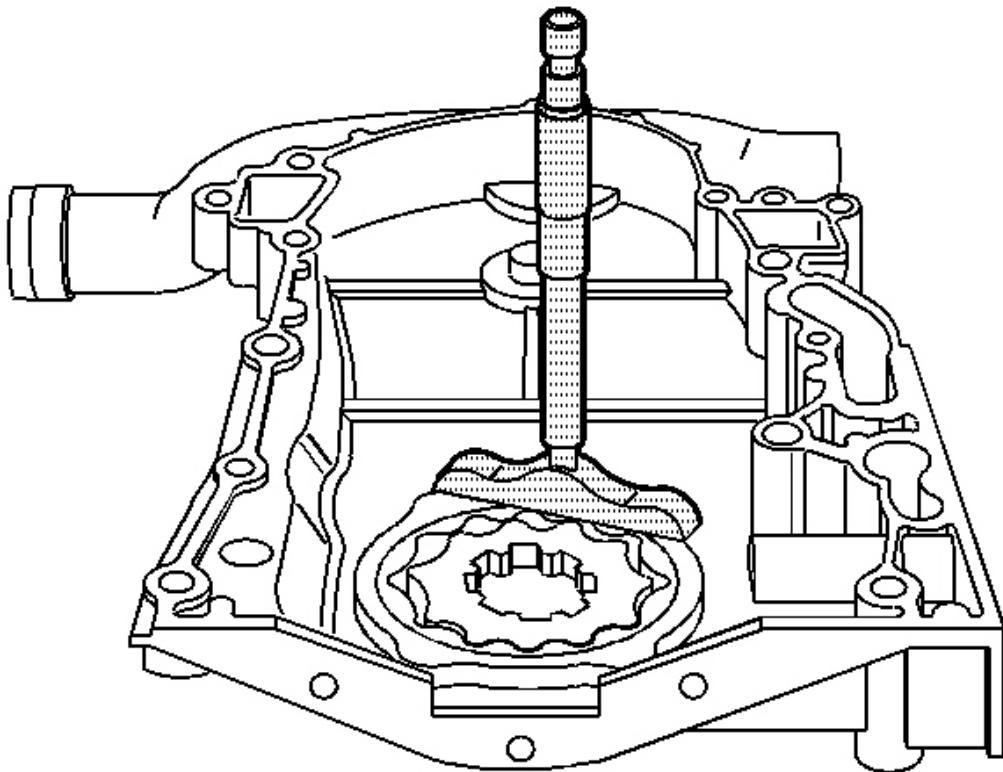
If the clearance for the inner oil pump gear tip is greater than 0.152 mm (0.006 in) the oil pump must be replaced.



**Fig. 428: Measuring Outer Oil Pump Gear Diameter Clearance**  
Courtesy of GENERAL MOTORS CORP.

8. Measure the outer oil pump gear diameter clearance.

If the outer oil pump gear diameter clearance is greater than 0.381 mm (0.015 in) the oil pump must be replaced.



**Fig. 429: Measuring Outer Oil Pump Gear End Clearance**

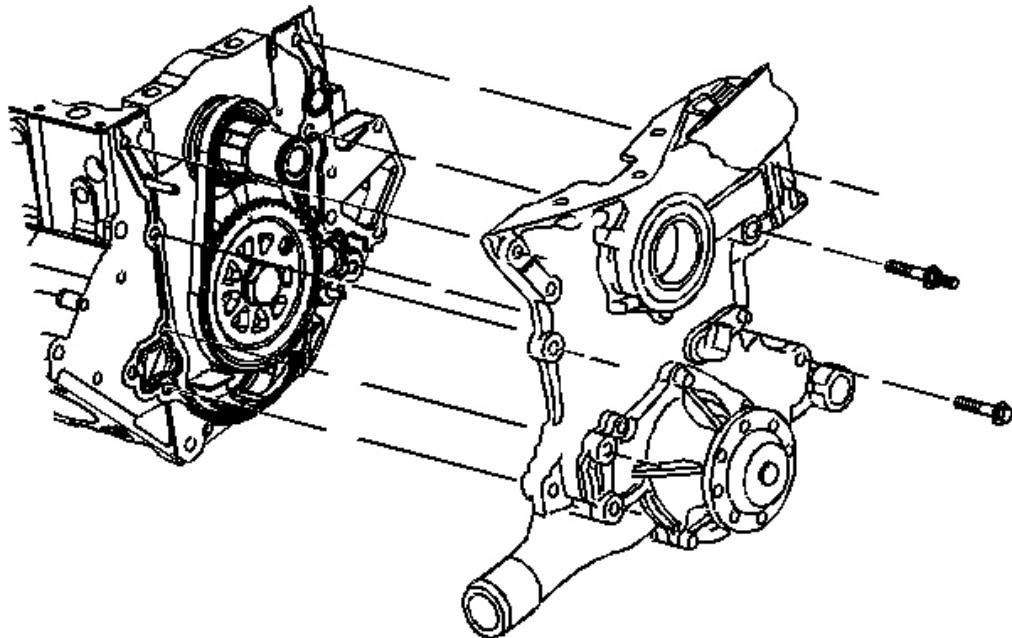
Courtesy of GENERAL MOTORS CORP.

9. Measure the oil pump gear end clearance.
10. Measure the pressure regulator valve-to-bore clearance.

If the pressure regulator valve-to-bore clearance is greater than 0.076 mm (0.003 in) the oil pump must be replaced.

#### **ENGINE FRONT COVER CLEANING AND INSPECTION**

##### **Cleaning and Inspection Procedure**

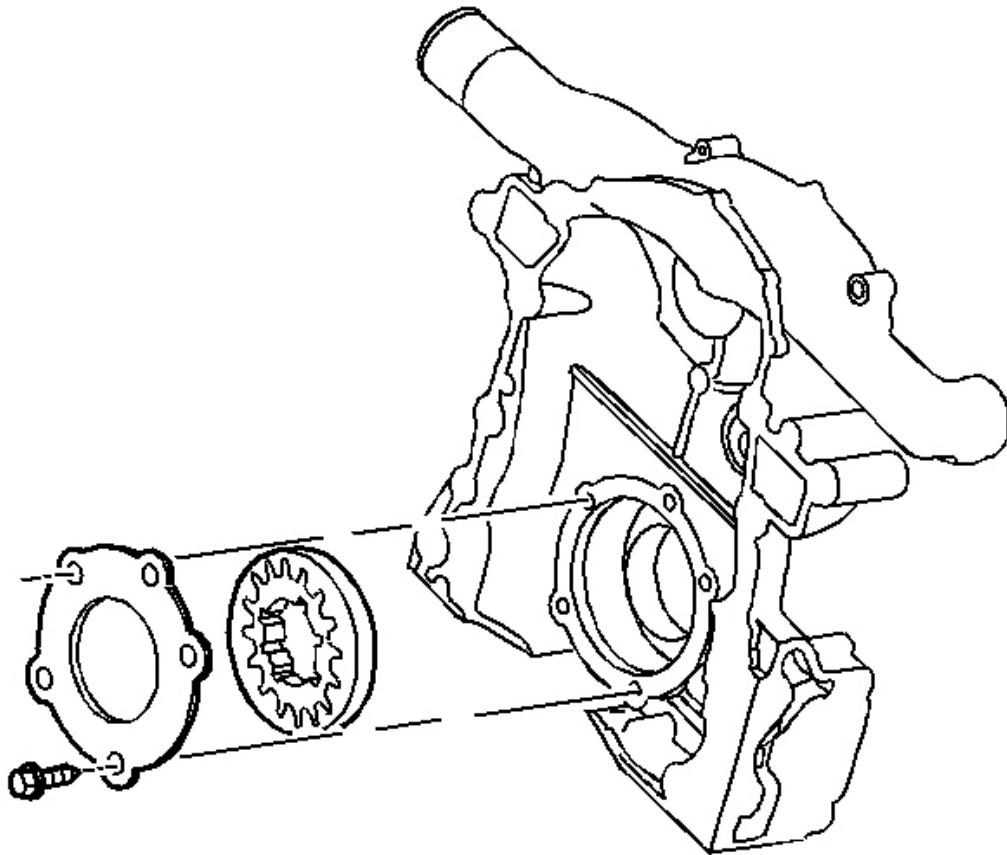


**Fig. 430: View Of Engine Front Cover**  
Courtesy of GENERAL MOTORS CORP.

1. Clean the engine front cover mating surface.
2. Clean the engine front cover.
3. Inspect the engine front cover threaded holes.
4. Inspect the engine front cover for damage.
5. Inspect the engine front cover mating surfaces for nicks.
6. Repair or replace the engine front cover as necessary.

## OIL PUMP ASSEMBLE

### Assembly Procedure



**Fig. 431: Exploded View Of Oil Pump Components**  
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the oil pump gears with petroleum jelly.
2. Install the oil pump gears.
3. Pack the oil pump cavity with petroleum jelly.
4. Install the oil pump cover.

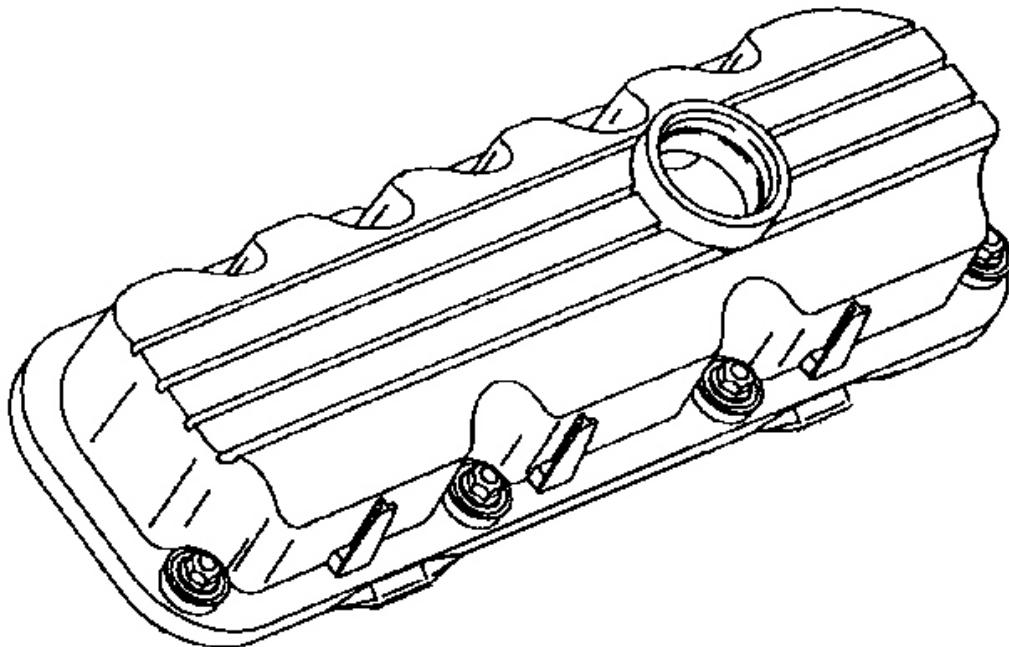
**NOTE: Refer to FASTENER NOTICE .**

5. Install the oil pump cover screws.

**Tighten:** Tighten the screws to 11 N.m (98 lb in).

## VALVE ROCKER ARM COVER CLEANING AND INSPECTION

### Cleaning and Inspection Procedure

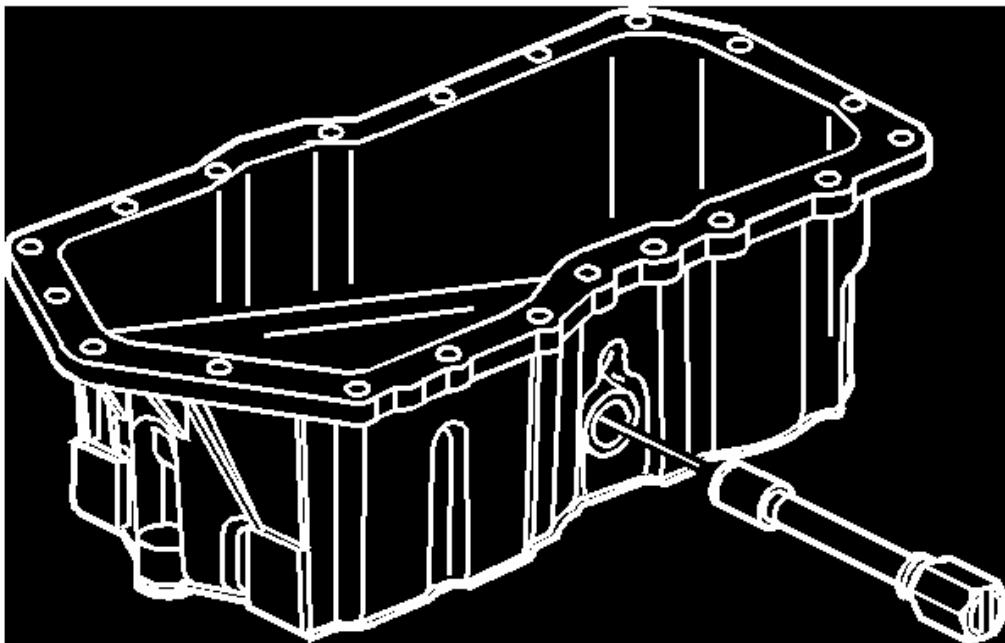


**Fig. 432: Cleaning/Inspecting Valve Rocker Arm Cover**

Courtesy of GENERAL MOTORS CORP.

1. Clean the valve rocker arm cover mating surface.
2. Clean the valve rocker arm cover. Remove all the sludge and the oil deposits.
3. Inspect the valve rocker arm cover for damage. Replace the valve rocker arm cover if any damage is found.

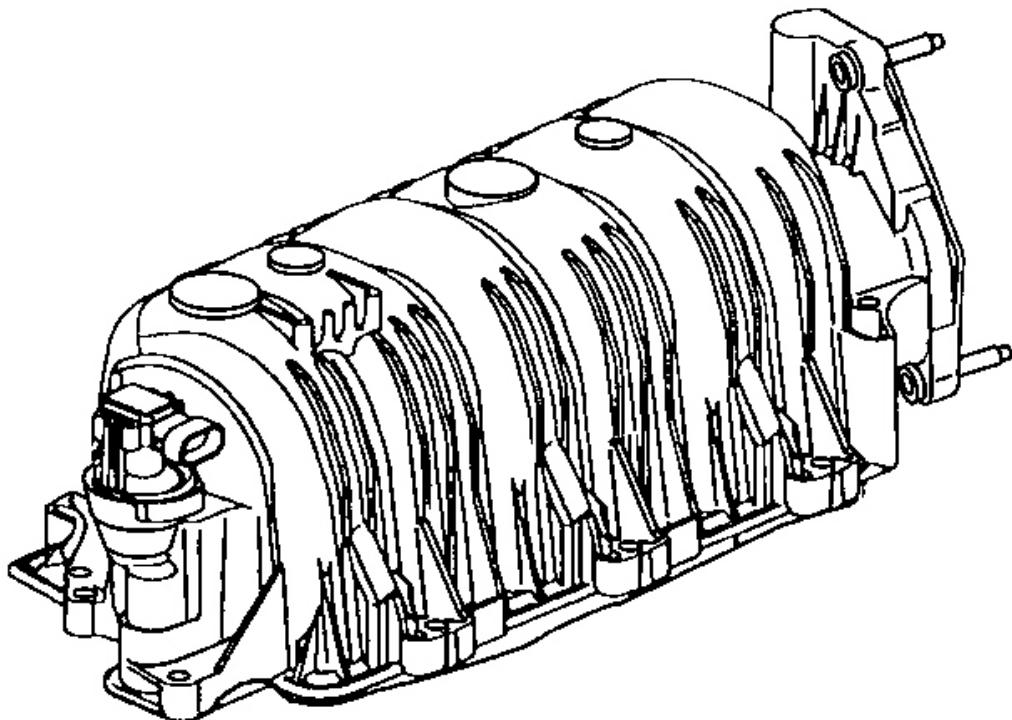
## OIL PAN CLEANING AND INSPECTION



**Fig. 433: Cleaning/Inspecting Oil Pan**  
Courtesy of GENERAL MOTORS CORP.

- Clean the oil pan mating surface.
- Clean the oil pan. Remove all the sludge and the oil deposits.
- Inspect the threads for the oil level sensor and the engine oil drain plug.
- Inspect the oil pan for distortion.
- Repair or replace the oil pan as necessary.

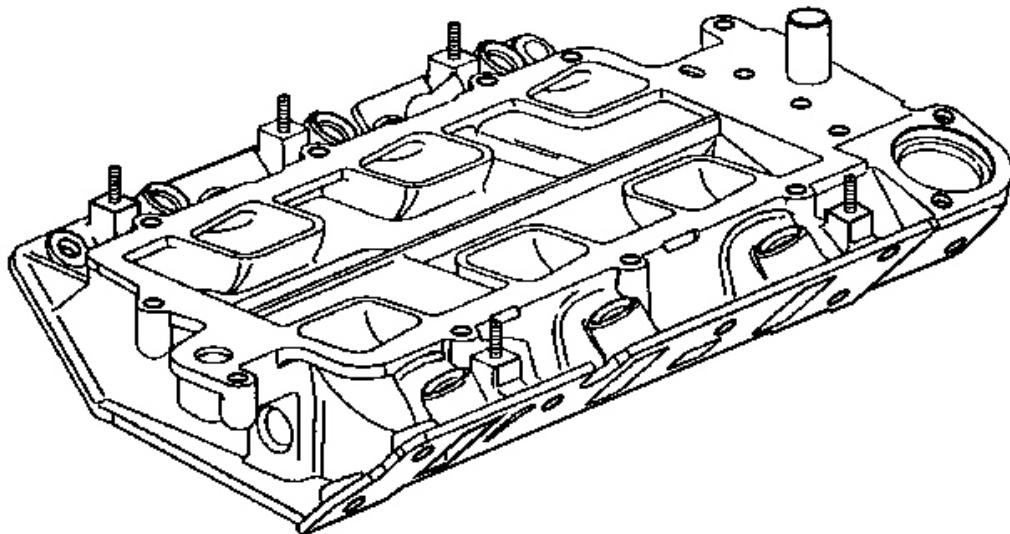
#### UPPER INTAKE MANIFOLD CLEANING AND INSPECTION



**Fig. 434: View of Upper Intake Manifold**  
Courtesy of GENERAL MOTORS CORP.

- Clean the upper intake manifold mating surfaces.
- Clean the upper intake manifold.
- Inspect the upper intake manifold for damage.
- Replace the upper intake manifold as necessary.

#### **LOWER INTAKE MANIFOLD CLEANING AND INSPECTION**



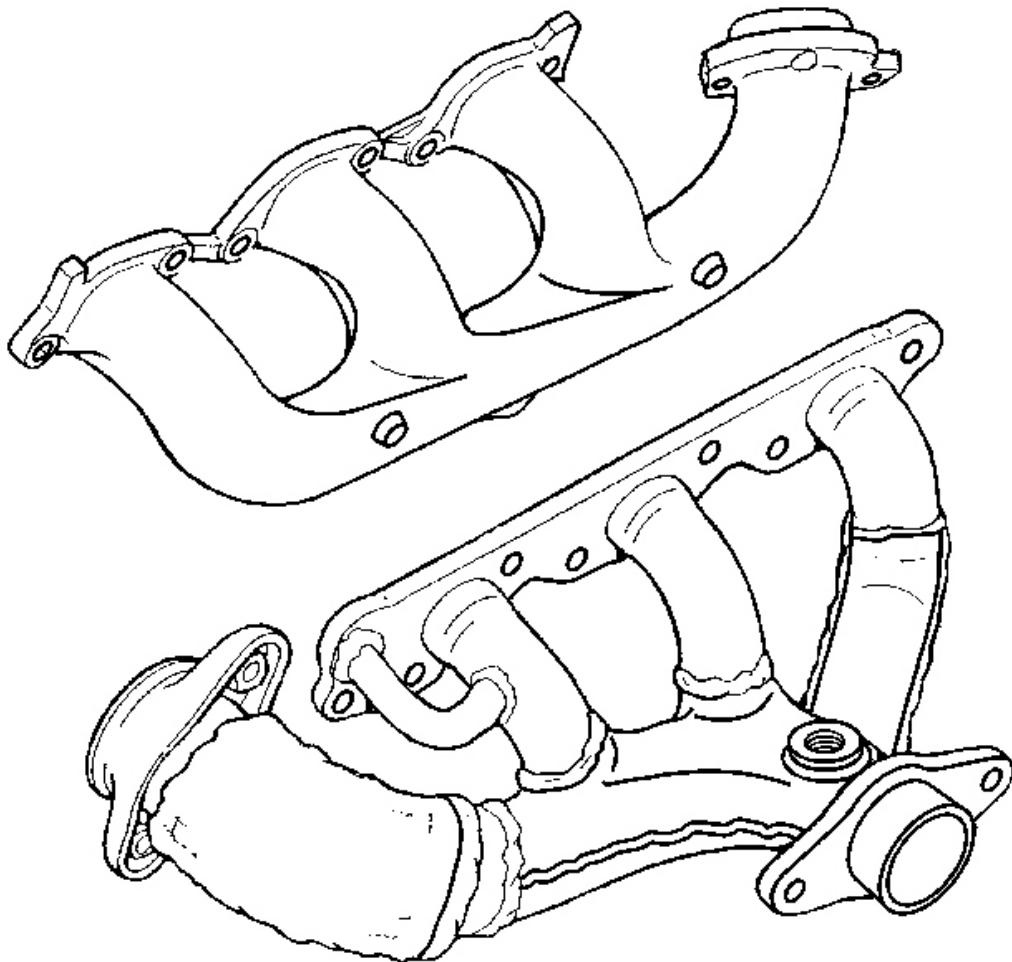
**Fig. 435: View of Lower Intake Manifold**

Courtesy of GENERAL MOTORS CORP.

- Clean the lower intake manifold mating surfaces.
- Clean the lower intake manifold.
- Inspect the threaded holes for damage.
- Inspect the lower intake manifold for damage or nicks in the mating surfaces.
- Replace or repair the lower intake manifold as necessary.

## **EXHAUST MANIFOLD CLEANING AND INSPECTION**

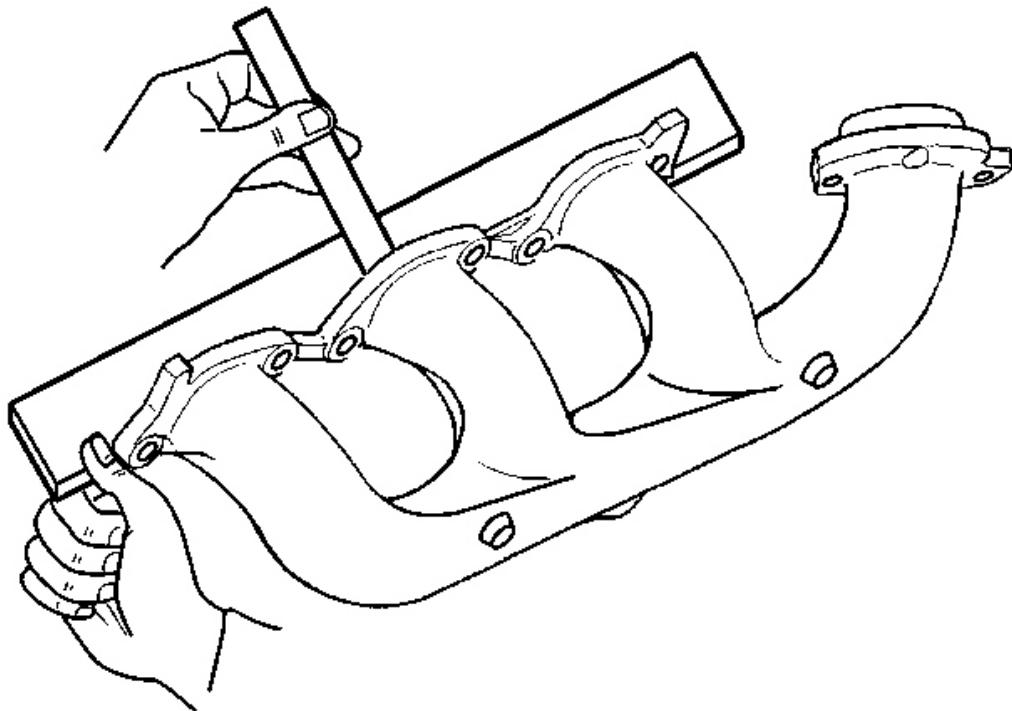
### **Cleaning and Inspection Procedure**



**Fig. 436: View of Exhaust Manifold**

Courtesy of GENERAL MOTORS CORP.

1. Clean the exhaust manifold mating surfaces.
2. Clean the exhaust manifold.
3. Inspect the exhaust manifold mating surfaces for damage.

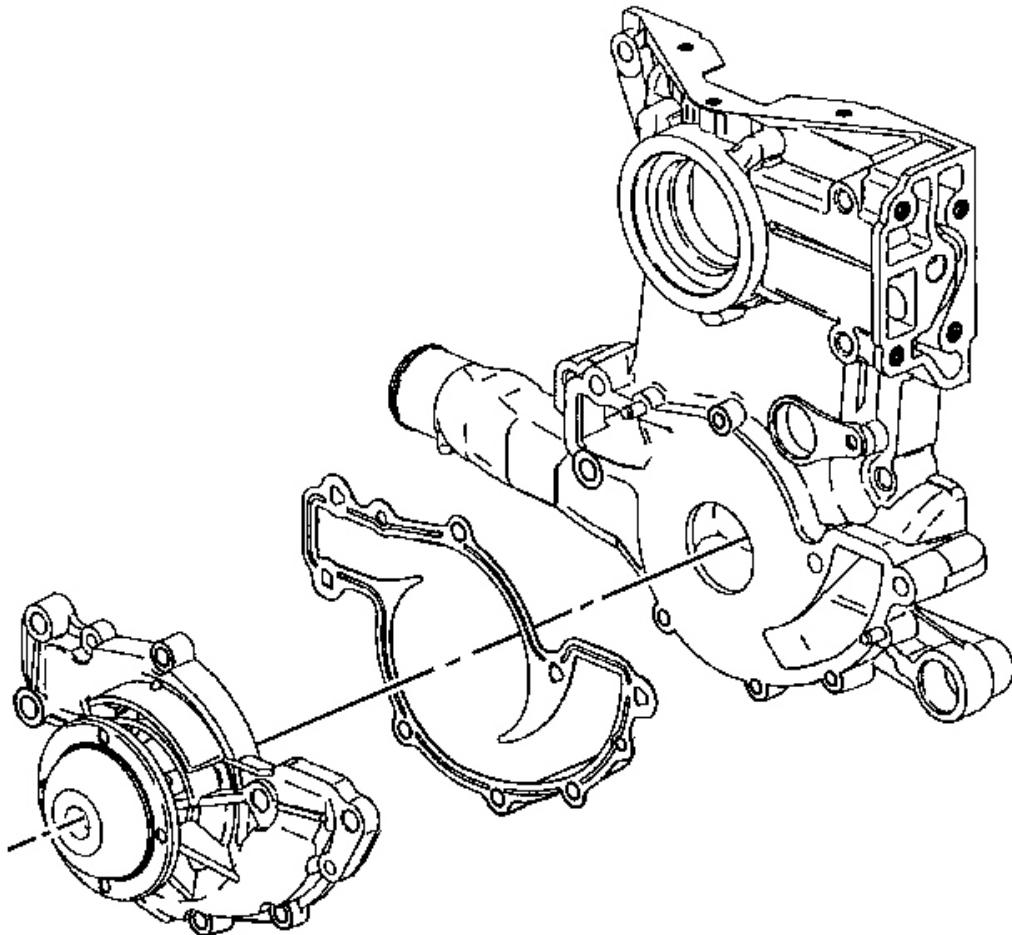


**Fig. 437: Inspecting Exhaust Manifold Flange For Straightness**  
Courtesy of GENERAL MOTORS CORP.

4. Inspect the exhaust manifold flange for straightness, using a straight edge and a feeler gage.
5. If the exhaust manifold flange is warped more than 0.05 mm (0.002 in) replace the exhaust manifold.

## **WATER PUMP CLEANING AND INSPECTION**

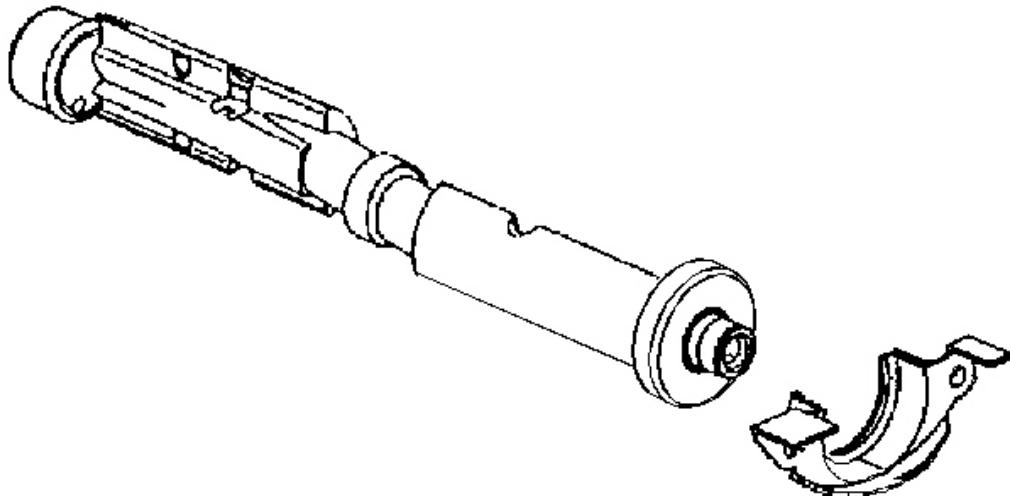
### **Cleaning and Inspection Procedure**



**Fig. 438: Inspecting Water Pump & Components**  
Courtesy of GENERAL MOTORS CORP.

1. Clean the water pump mating surface.
2. Clean the water pump.
3. Inspect the water pump shaft for looseness.
4. Inspect the water pump vanes for damage.
5. Inspect the water pump mating surfaces for nicks.
6. Repair or replace the water pump as necessary.

**Cleaning and Inspection Procedure**



**Fig. 439: View of Balance Shaft**

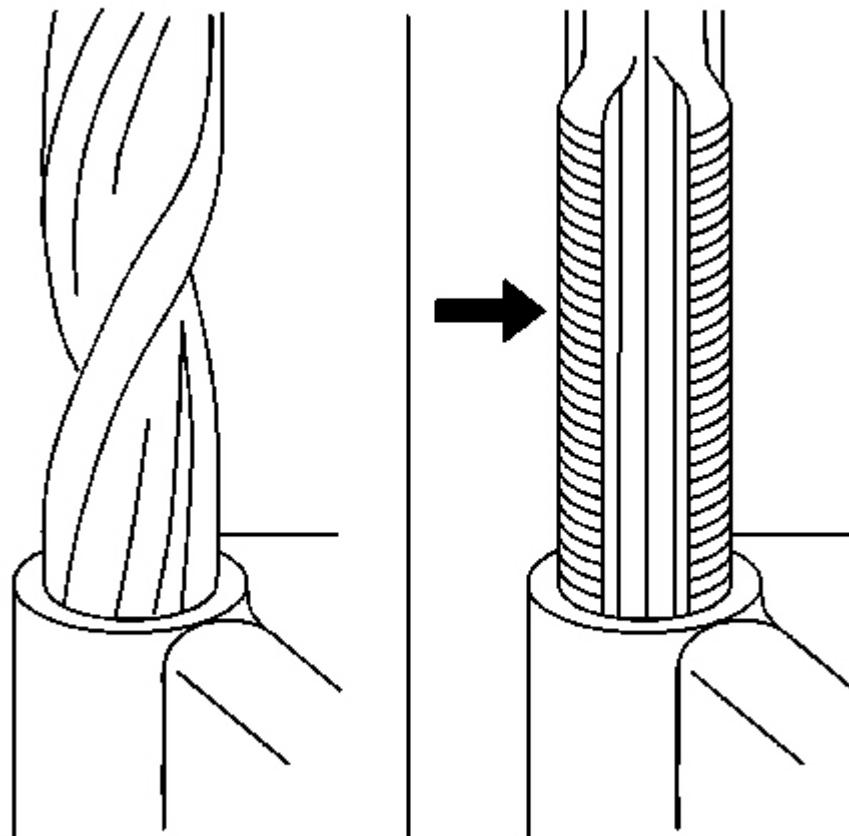
Courtesy of GENERAL MOTORS CORP.

1. Clean the balance shaft.
2. Inspect the balance shaft bearing/bushing journals for excessive wear.
3. Inspect the balance shaft driven gear and the balance shaft drive gear for nicks and burrs.
4. Inspect the balance shaft retainer for damage.
5. Inspect the balance shaft threads for damage.
6. Repair or replace the balance shaft components as necessary.

**THREAD REPAIR**

General purpose thread repair kits are available commercially.

**Repair Procedure**



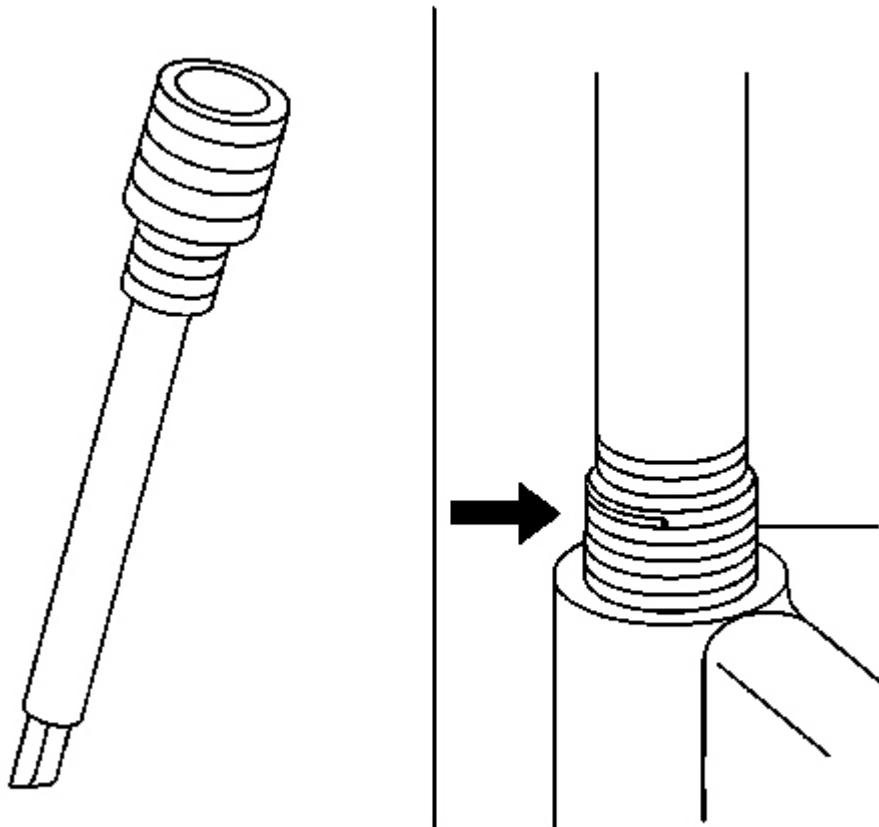
**Fig. 440: Drilling & Tapping Damaged Threads**  
Courtesy of GENERAL MOTORS CORP.

**CAUTION: Refer to Safety Glasses Caution .**

**IMPORTANT: Refer to the thread repair kit manufacturer's instructions regarding the size of the drill and which tap to use. Always avoid any buildup of chips. Back out the tap every few turns and remove the chips.**

1. Determine the size, the pitch and the depth of the damaged thread.

2. Adjust the stop collars on the cutting tool as needed. Tap the stop collars to the required depth.
3. Drill out the damaged thread.
4. Remove the chips.
5. Apply clean engine oil to the top thread.
6. Use the tap in order to cut new thread.
7. Clean the thread.



**Fig. 441: Installing Thread Insert**

Courtesy of GENERAL MOTORS CORP.

8. Screw the thread insert onto the mandrel of the thread insert installer. Engage the tang of the

thread insert onto the end of the mandrel.

**IMPORTANT: The thread insert should be flush to 1 turn below the surface.**

9. Lubricate the thread insert with clean engine oil - except when installing in aluminum - and install the thread insert.
10. If the tang of the thread insert does not break off when backing out the thread insert installer, break off the tang using a drift punch.

**SERVICE PRIOR TO ASSEMBLY**

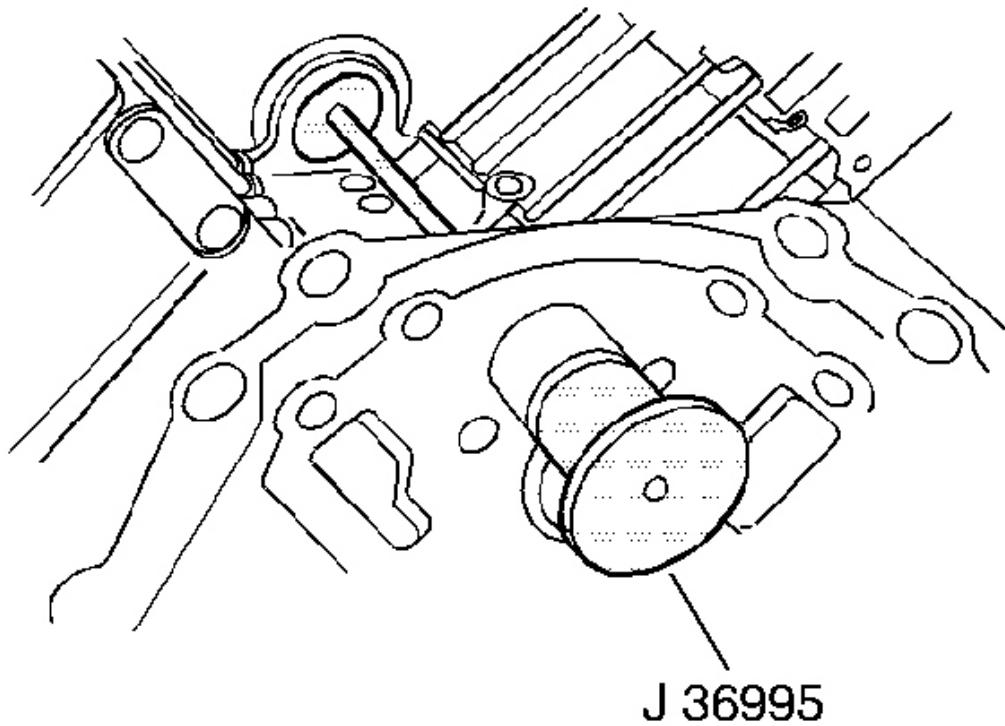
Dirt will cause premature wear of the rebuilt engine. Clean all of the components. Use the proper tools in order to measure components when inspecting for excessive wear. Repair or replace the components that are not within the manufacturers specification. When components are reinstalled into an engine, return the components to their original location, position and direction. During assembly, lubricate all of the moving parts with clean engine oil or engine assembly lubricant unless otherwise specified. This will provide initial lubrication when the engine is first started.

**BALANCE SHAFT BEARING AND/OR BUSHING INSTALLATION**

**Tools Required**

- **J 21465-13** Drive Handle Extension. See [Special Tools](#).
- **J 36995** Balance Shaft Bearing Remover/Installer. See [Special Tools](#).

**Installation Procedure**

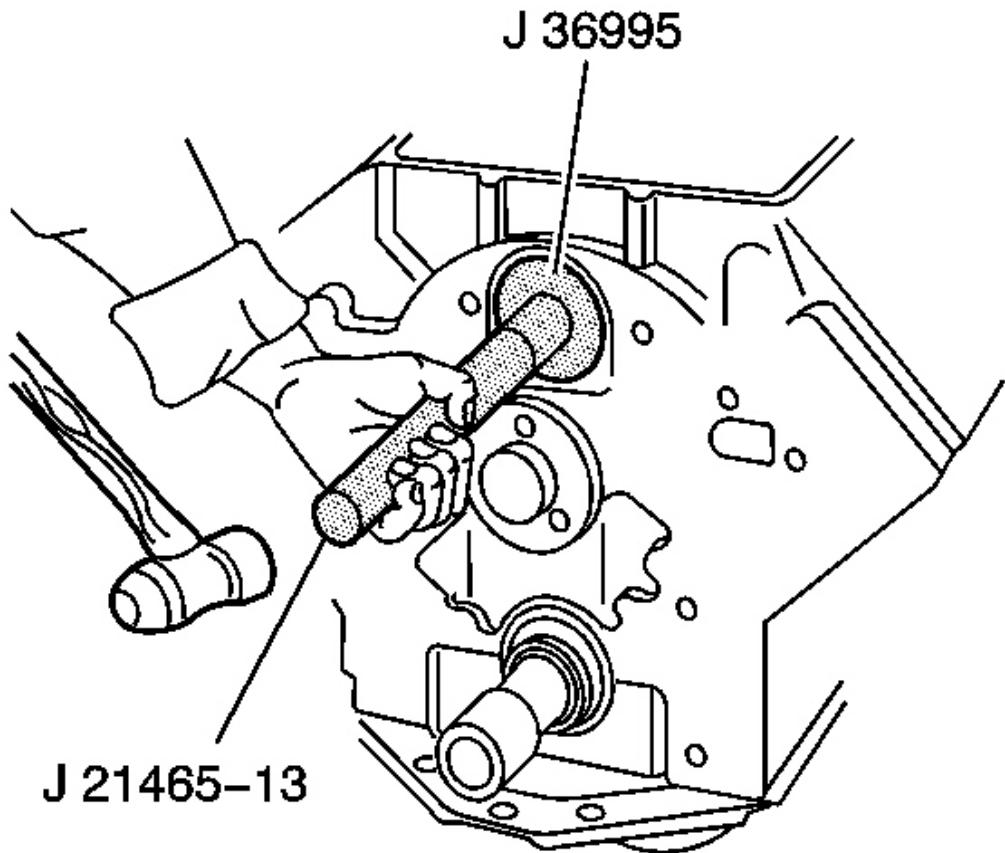


**Fig. 442: Installing Balance Shaft Bushing**

Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** The J 36995 installs the balance shaft bushing to the correct depth. See Special Tools. The balance shaft bushing is properly installed when J 36995 fully contacts the balance shaft bore or the engine block/transaxle mounting flange. See Special Tools.

1. Dip the balance shaft bushing in clean engine oil.
2. Use the balance shaft bushing installers to install the balance shaft bushing.
3. Remove **J 36995**. See Special Tools.



**Fig. 443: Installing Balance Shaft Bearing**  
Courtesy of GENERAL MOTORS CORP.

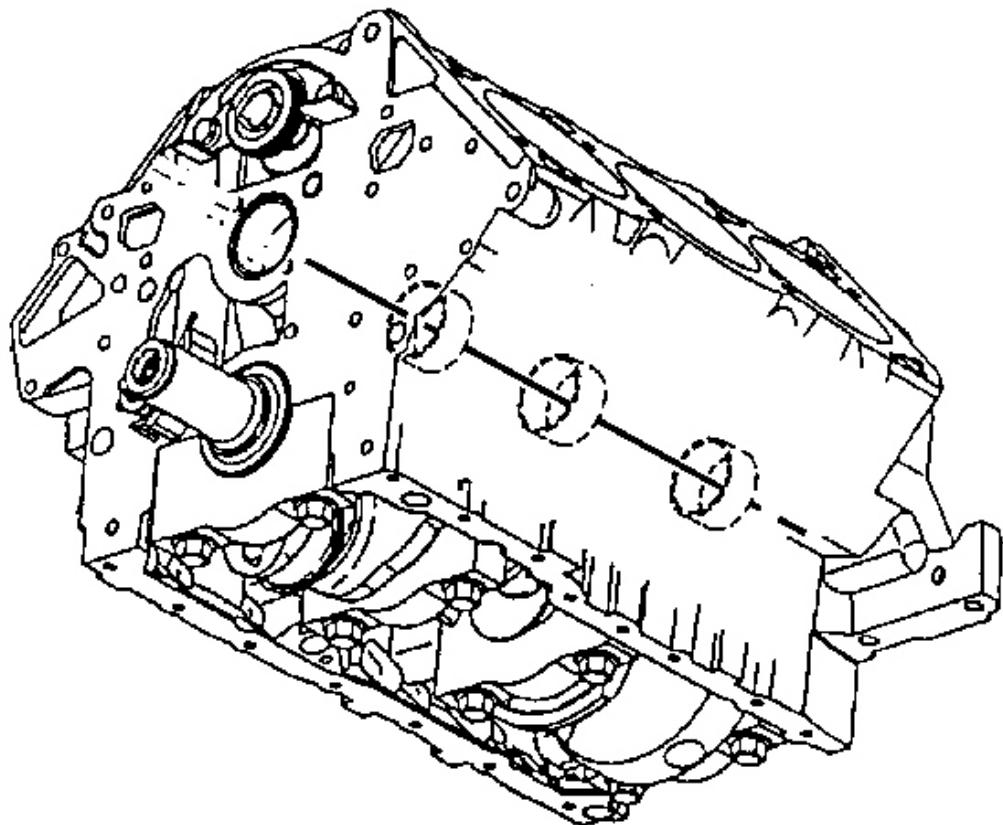
4. Dip the balance shaft bearing into clean engine oil.
5. Use **J 21465-13** and **J 36995** to install the balance shaft bearing into the engine block. See **Special Tools**.

#### CAMSHAFT BEARING INSTALLATION

##### Tools Required

**J 33049** Camshaft Bearing Service Set

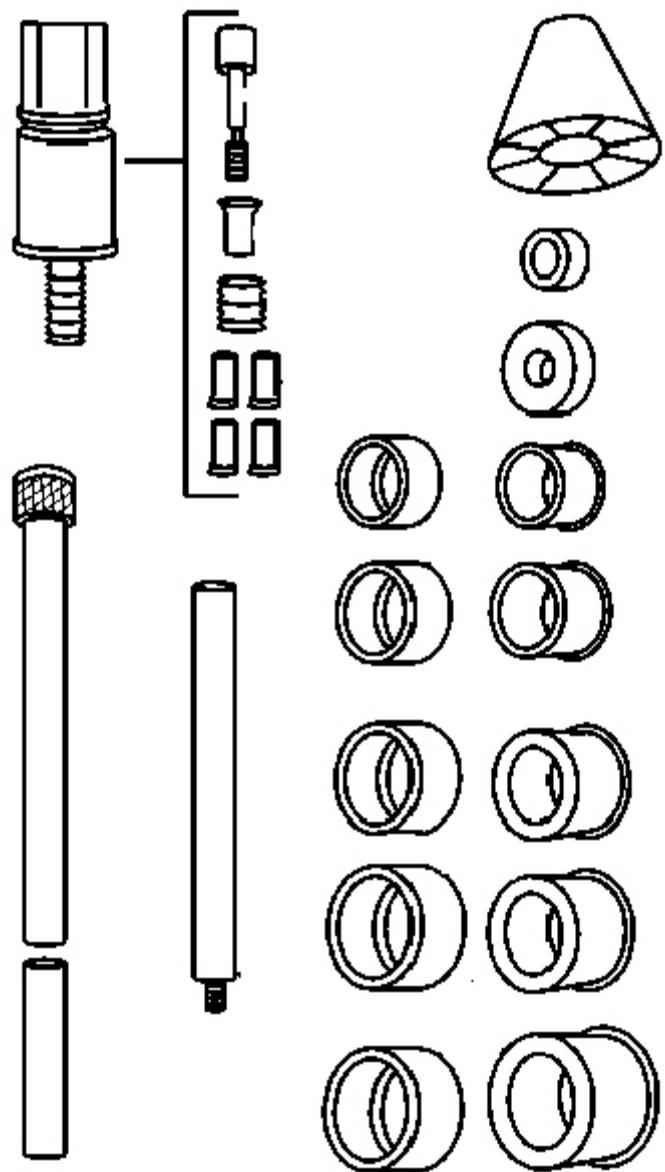
##### Installation Procedure



**Fig. 444: Identifying Camshaft Bearings**

Courtesy of GENERAL MOTORS CORP.

1. Select the camshaft bearings.



**Fig. 445: Camshaft Bearing Service Set**  
Courtesy of GENERAL MOTORS CORP.

2. Use the following procedure to install the camshaft bearings:
  1. Assemble **J 33049** according to the manufacturer's instructions.

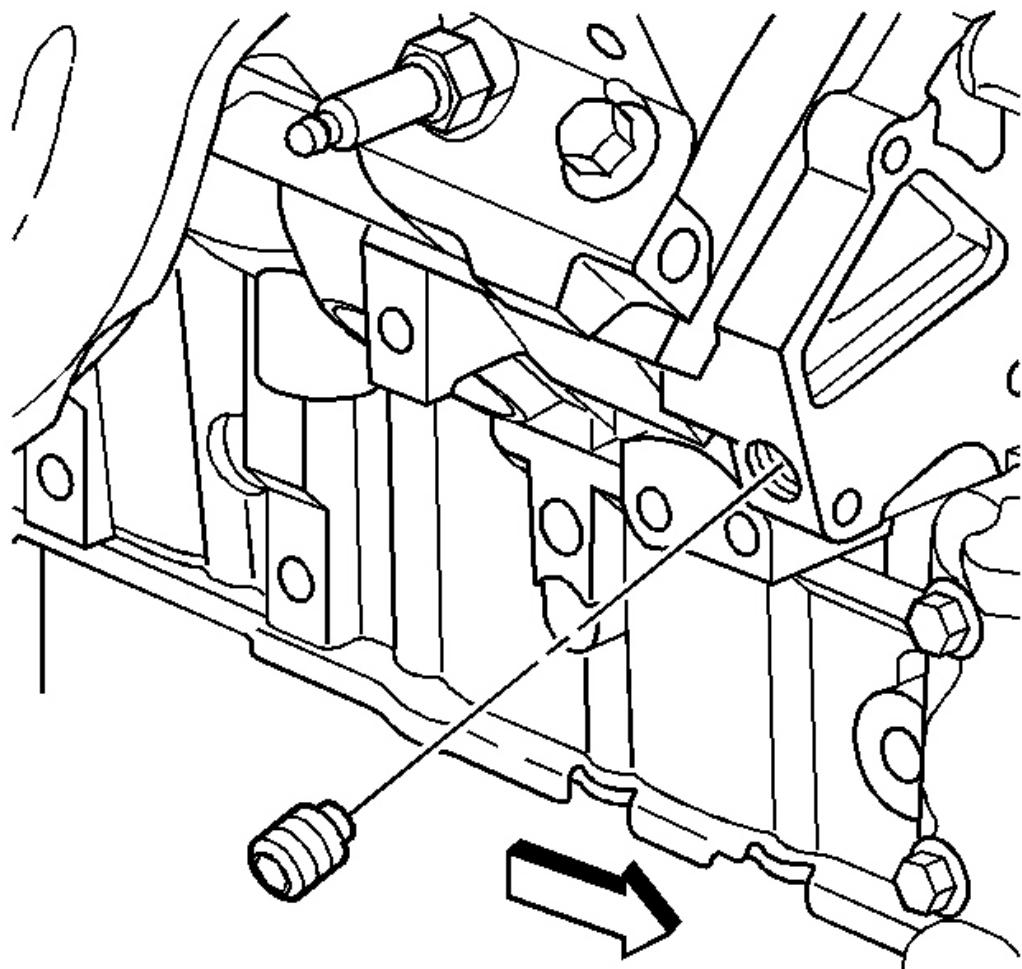
2. Place the bearing on the tool.

**NOTE: Severe engine damage may result if the oil holes are not correctly aligned.**

3. Index the bearing oil holes with the engine block oil passages.

## ENGINE BLOCK PLUG INSTALLATION

### Installation Procedure



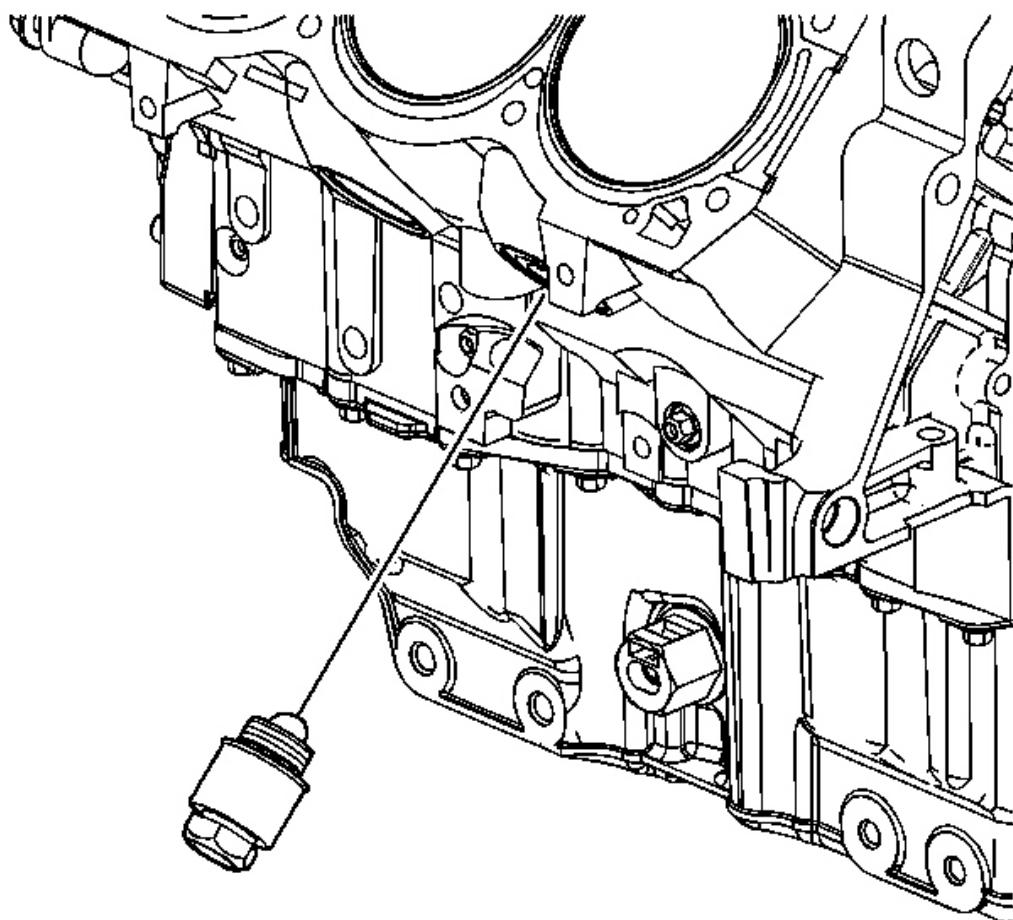
**Fig. 446: Locating Threaded Gallery Plugs**

Courtesy of GENERAL MOTORS CORP.

**NOTE:** Refer to FASTENER NOTICE .

1. Install the threaded oil gallery plugs.

**Tighten:** Tighten the oil gallery plugs to 30 N.m (22 lb ft).



**Fig. 447: Threaded Engine Block Heater**

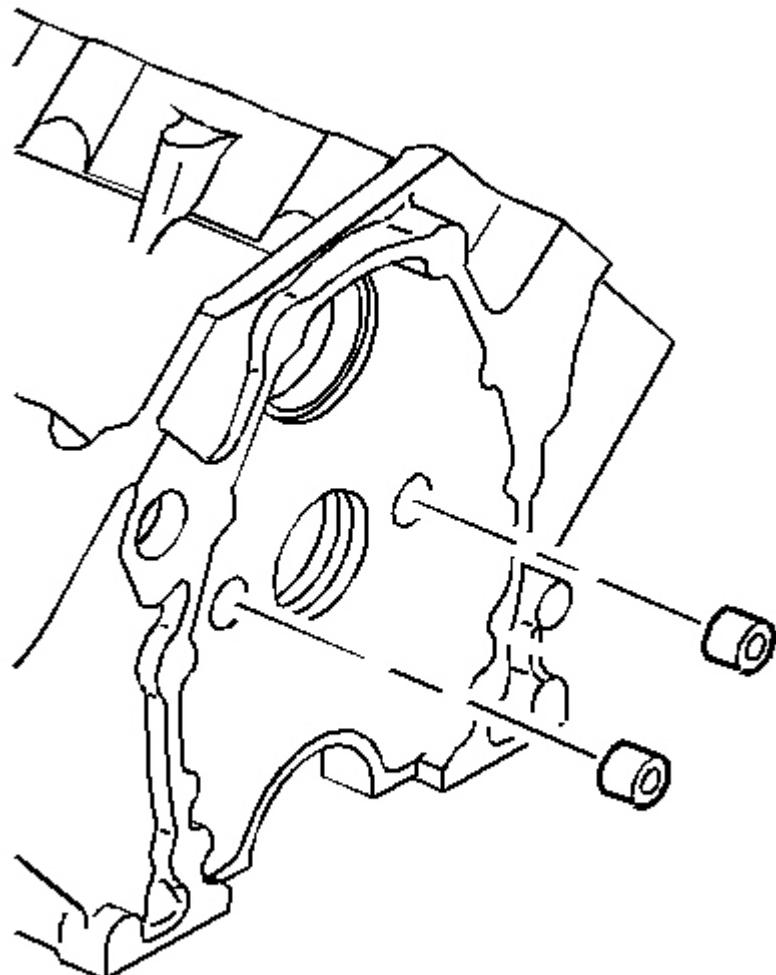
Courtesy of GENERAL MOTORS CORP.

2. Apply sealant GM P/N 12346004 (Canadian P/N 10953480) or equivalent to the threads of

the engine block heater.

3. Install the engine block heater.

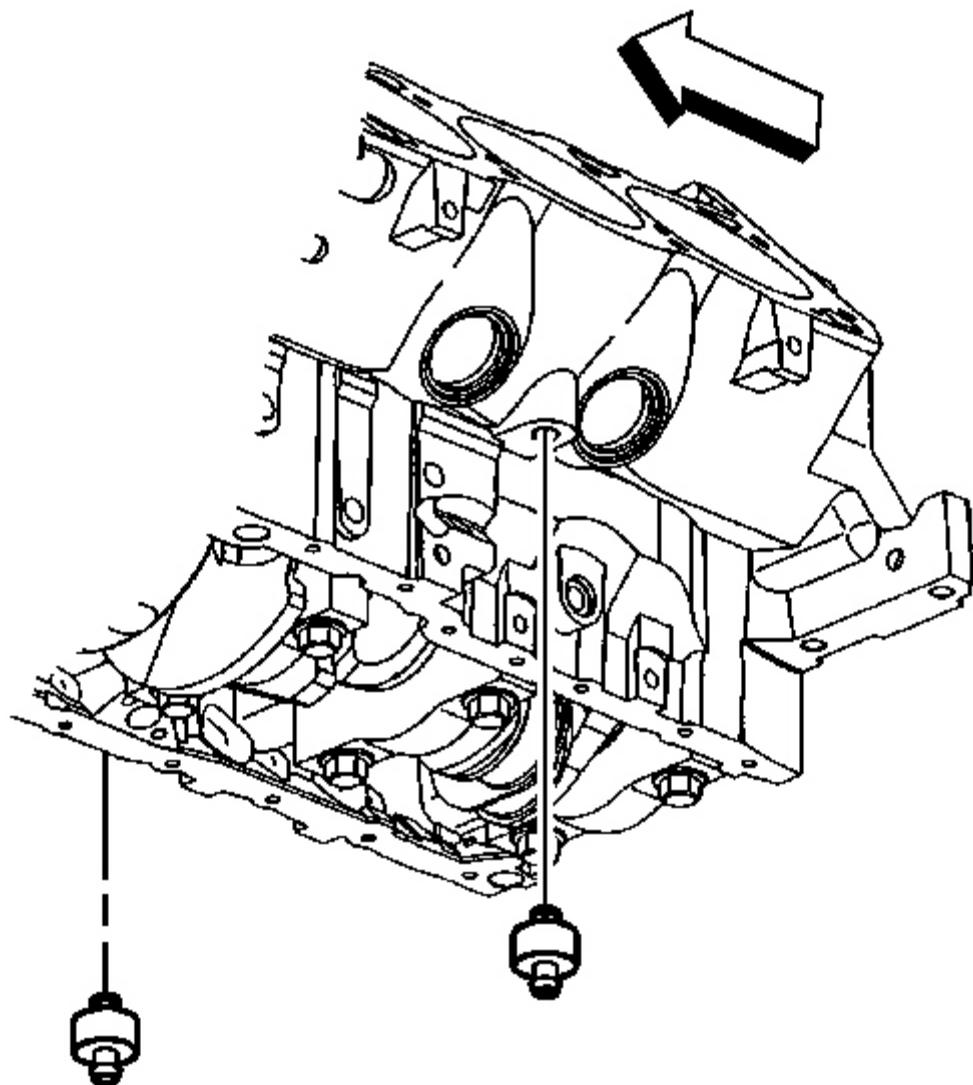
**Tighten:** Tighten to 50 N.m (37 lb ft).



**Fig. 448: Locating Engine Block Plugs**

Courtesy of GENERAL MOTORS CORP.

4. Install the remaining oil gallery plugs using GM P/N 12346004 (Canadian P/N 10953480) or the equivalent.



**Fig. 449: Identifying Knock Sensors**  
Courtesy of GENERAL MOTORS CORP.

5. Apply sealant GM P/N 12346004 (Canadian P/N 10953480) or the equivalent to the threads of the knock sensor.
6. Install the knock sensors.

**Tighten:** Tighten the knock sensors to 18 N.m (13 lb ft).

7. Install the knock sensor heat shield and bolts, if applicable.

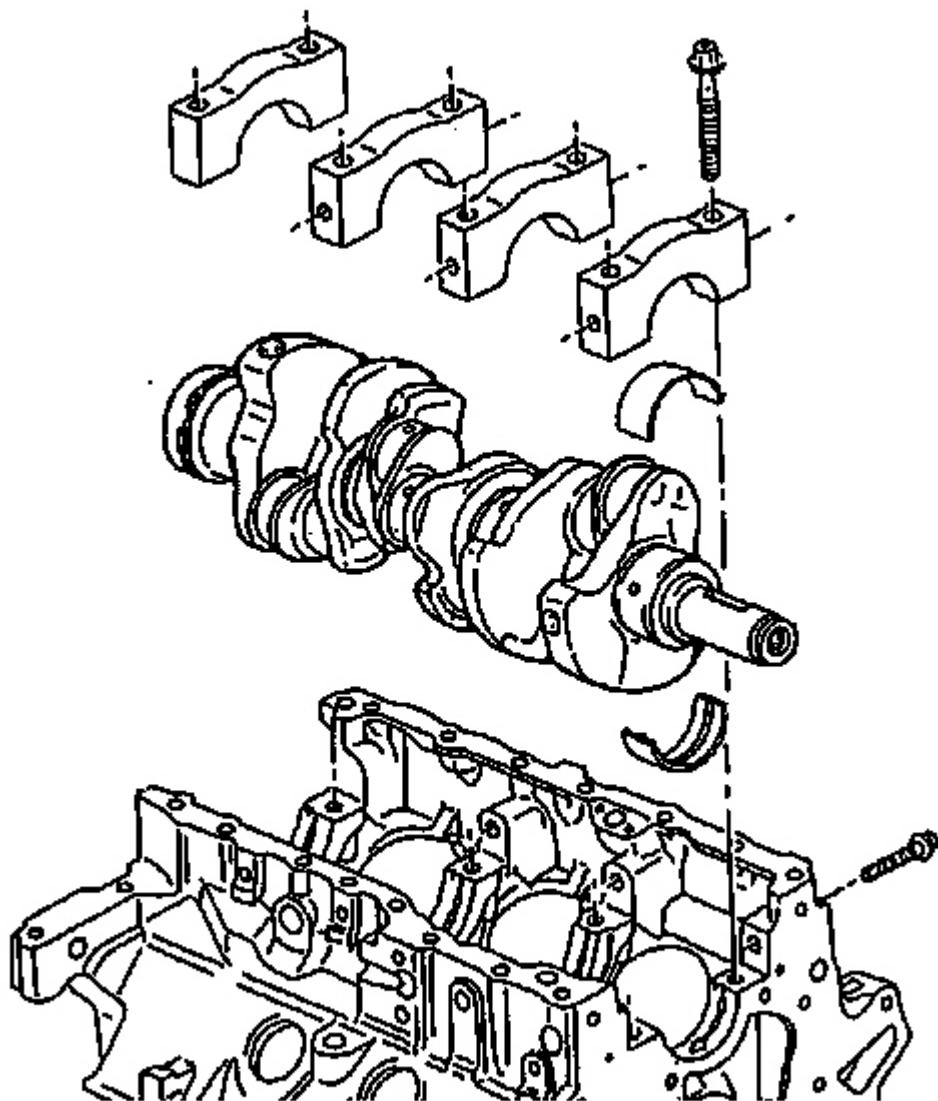
**Tighten:** Tighten the knock sensor heat shield bolts to 50 N.m (37 lb ft).

## **CRANKSHAFT AND BEARING INSTALLATION**

### **Tools Required**

**J 45059** Angle Meter. See **Special Tools**.

### **Installation Procedure**

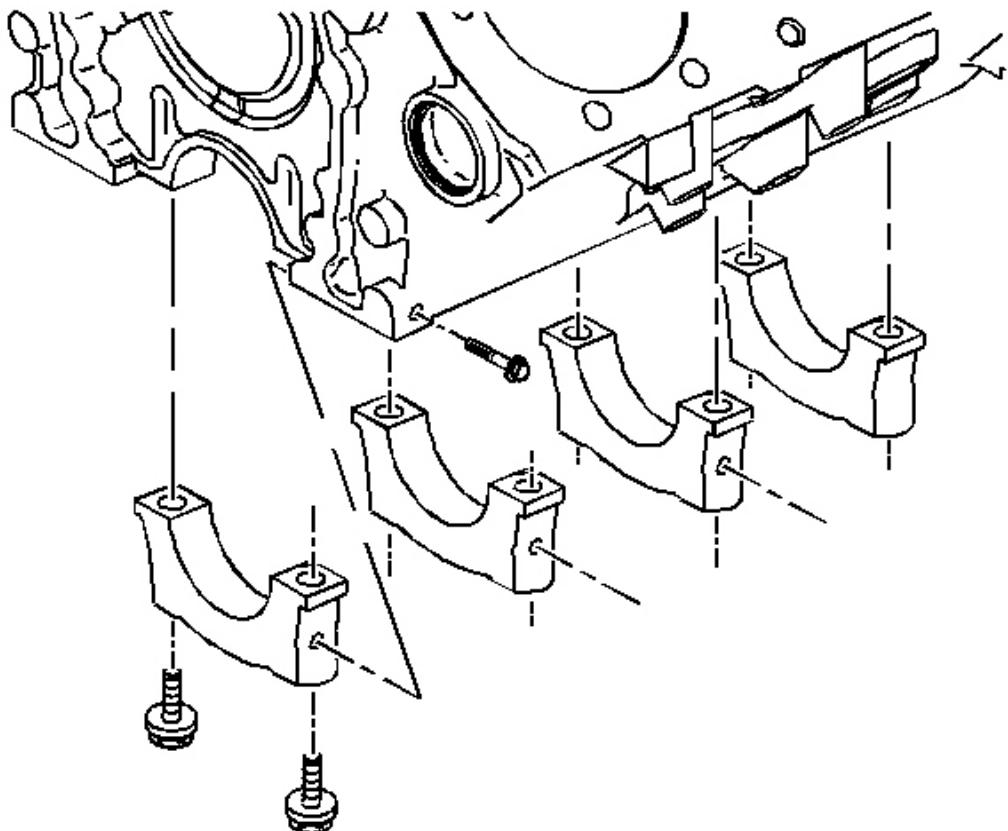


**Fig. 450: View Of Crankshaft, Bearings And Bearing Caps**  
Courtesy of GENERAL MOTORS CORP.

1. Install the upper crankshaft main bearings.
2. Install the crankshaft. Lubricate the crankshaft to crankshaft main bearing contact areas with engine oil or engine assembly lubricant.

**NOTE:** In order to prevent the possibility of cylinder block or crankshaft bearing cap damage, the crankshaft bearing caps are tapped into the cylinder block cavity using a brass, lead or a leather mallet before the attaching bolts are installed. Do not use attaching bolts to pull the crankshaft bearing caps into the seats. Failure to use this process may damage a cylinder block or a bearing cap.

3. Install the lower crankshaft main bearings into the main bearing caps.



**Fig. 451: Installing Lower Crankshaft Main Bearings Into Main Bearing Caps**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Refer to **SPECIAL FASTENER NOTICE** .

**NOTE:** Refer to **FASTENER NOTICE** .

4. Install the crankshaft main bearing cap bolts. Start the crankshaft main bearing cap bolts by hand. Ensure the bottom of the crankshaft main bearing cap is parallel to the bottom of the channel.

**Tighten:**

- Tighten the crankshaft main bearing cap bolts in equal increments. Do not completely tighten a bolt at a time in order to prevent the cap from being cocked.
- Tighten the bolts to 70 N.m (52 lb ft) to fully seat the crankshaft main bearing caps. Loosen the bolts 360 degrees counterclockwise.
- Tighten the bolts to 20 N.m (15 lb ft), then 40 N.m (30 lb ft).
- Use **J 45059** to tighten the bolts in steps: 35 degrees plus 35 degrees plus 40 degrees for a total of 110 degrees. See **Special Tools**.

5. Install the side main bolts. Apply GM P/N 12345493 (Canadian P/N 10953488) or equivalent to the side main bolts.

**Tighten:** Tighten the side crankshaft main bearing cap bolts to 15 N.m (11 lb ft). Use **J 45059** to tighten the bolts an additional 45 degrees. See **Special Tools**.

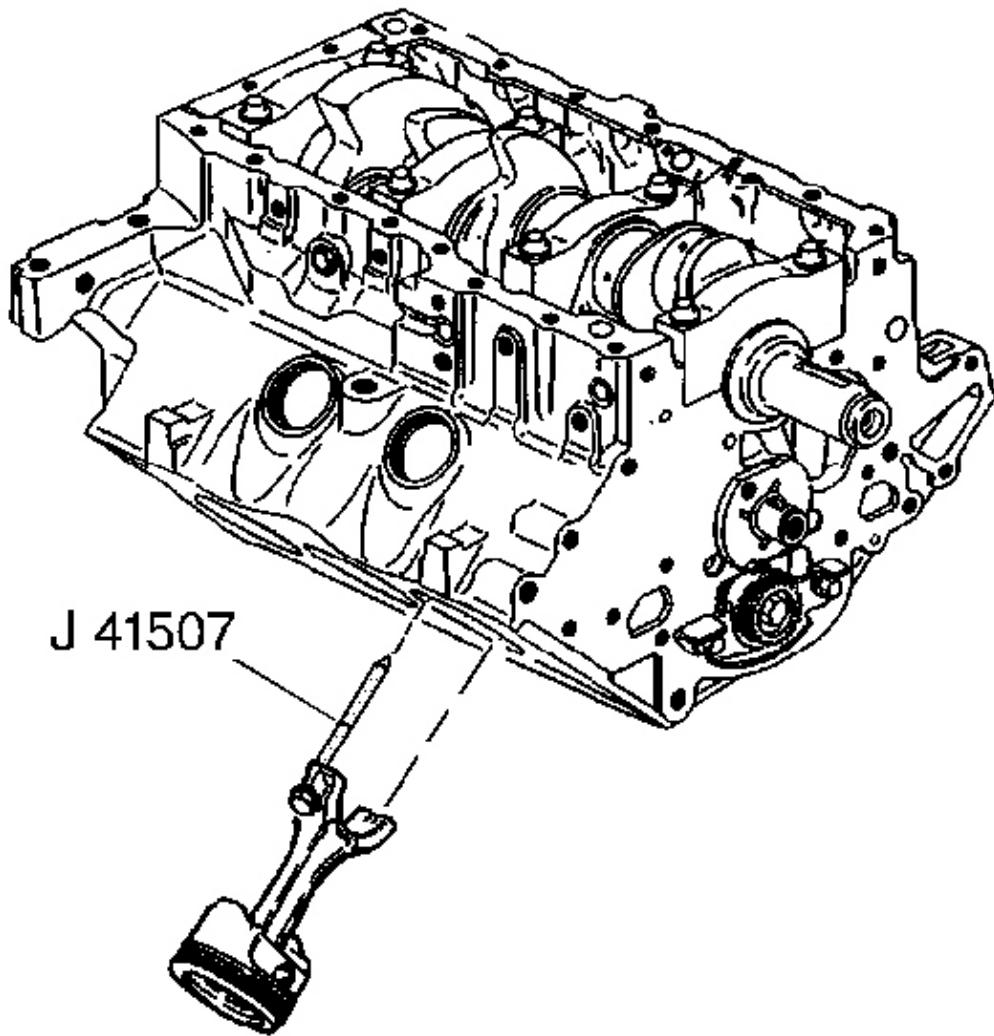
## PISTON, CONNECTING ROD AND BEARING INSTALLATION

### Tools Required

- **J 8037** Piston Ring Compressor. See **Special Tools**.
- **J 41507** Connecting Rod Guide Assembly. See **Special Tools**.
- **J 45059** Angle Meter. See **Special Tools**.

### Installation Procedure

1. Position the crankshaft so the connecting rod journal is opposite the piston and connecting rod assembly being installed. This will aid in the installation of the connecting rod assembly.
2. Lubricate the cylinder wall with engine oil.
3. Install the connecting rod bearing inserts.
4. Lubricate the connecting rod bearing insert surface with engine oil.



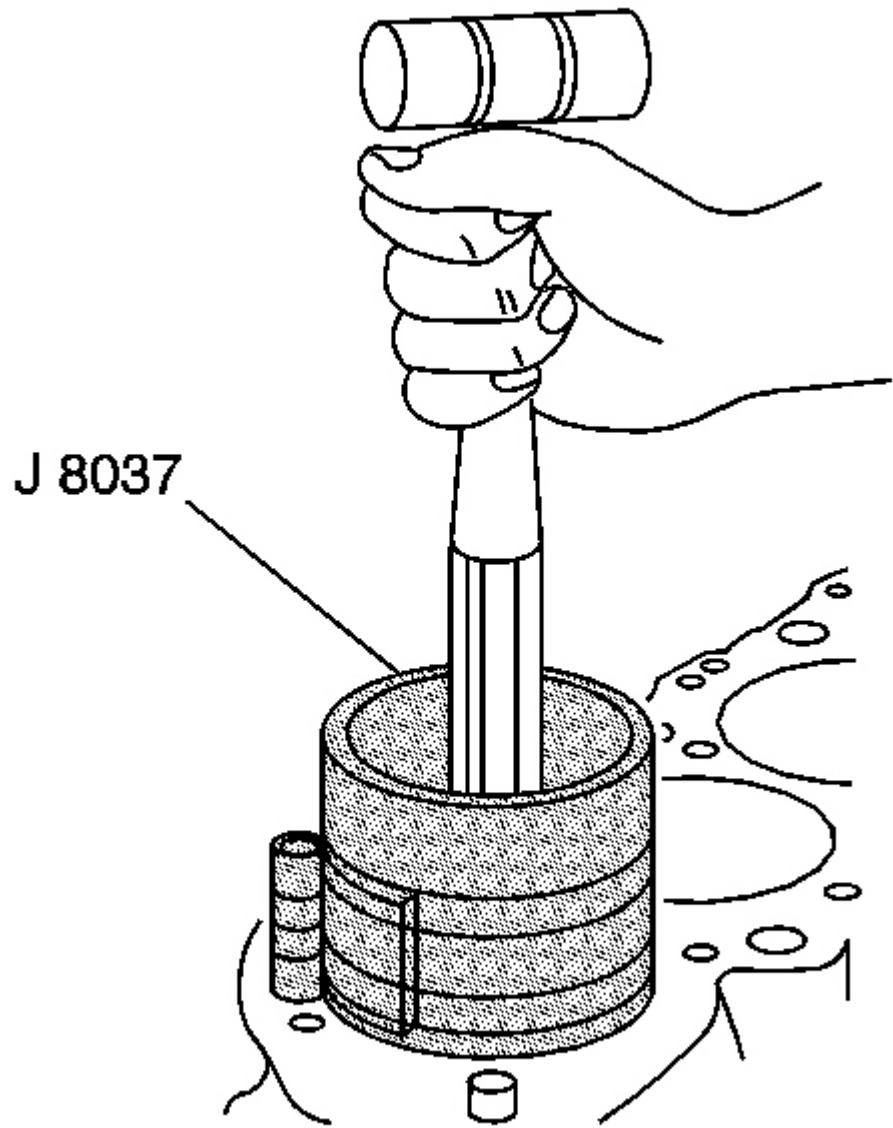
**Fig. 452: Installing J 41507 To Connecting Rod**

Courtesy of GENERAL MOTORS CORP.

5. Install **J 41507** to the connecting rod. See **Special Tools**. Hand tighten the tool to the connecting rod.
6. Install **J 8037** to the piston. See **Special Tools**.

**NOTE:** **Guide the lower connecting rod end carefully to avoid**

damaging the crankshaft journal.



**Fig. 453: Installing Piston & Connecting Rod Assembly Into Engine**  
Courtesy of GENERAL MOTORS CORP.

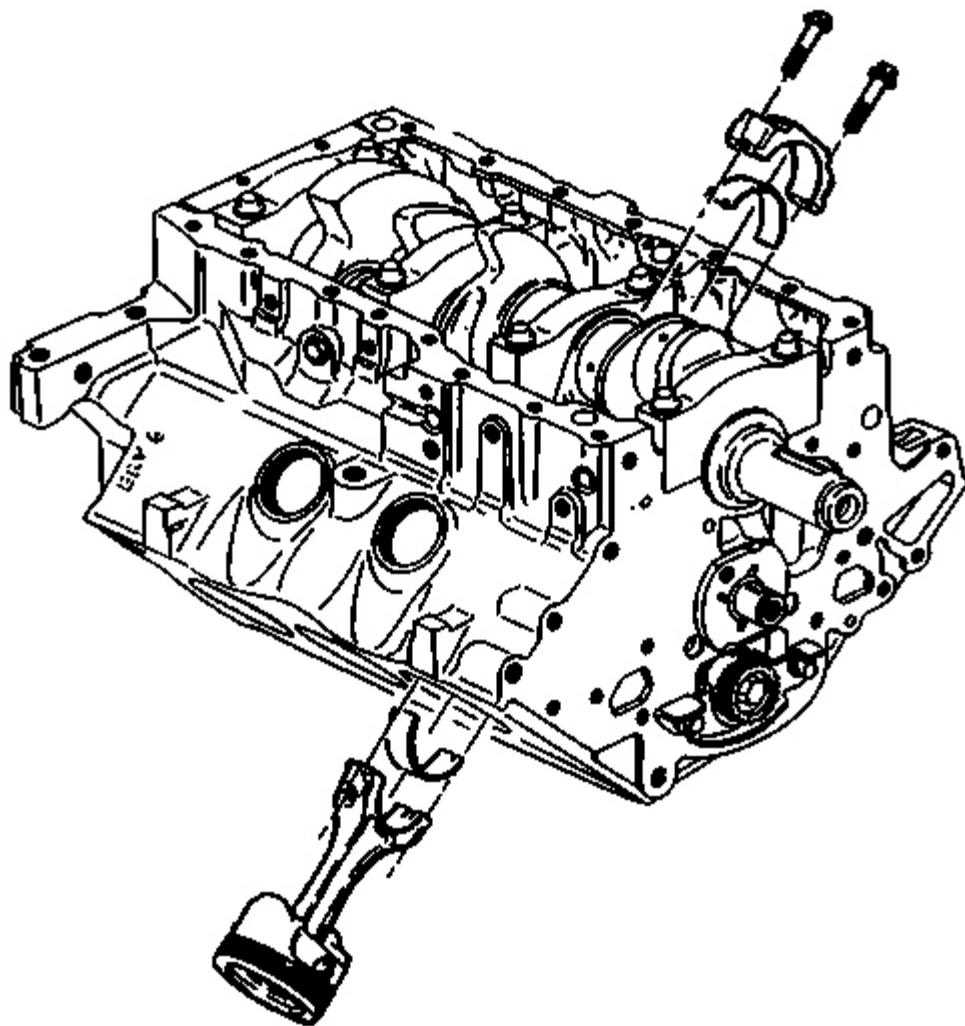
7. Use **J 8037** to compress the piston rings for installation of the piston and connecting rod

assembly. See Special Tools.

8. Install the piston and connecting rod assembly into the engine.

**IMPORTANT: Ensure the arrow on top of the piston or the markings made during removal face towards the front of the engine or are in the same location as when removed.**

9. Use **J 41507** to pull the connecting rod into place. See Special Tools.
10. Remove **J 41507** . See Special Tools.



**Fig. 454: Identifying Connecting Rod Bolts & Cap**  
Courtesy of GENERAL MOTORS CORP.

11. Install the connecting rod bearing cap.

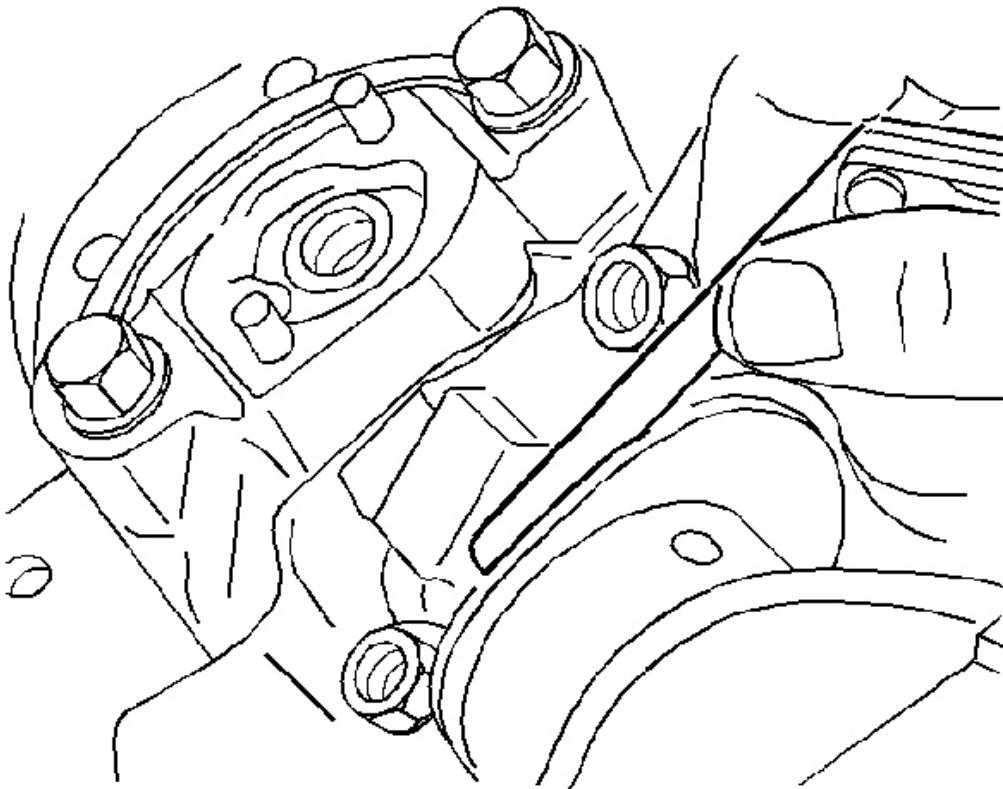
**NOTE:** Refer to SPECIAL FASTENER NOTICE .

**NOTE:** Refer to Fastener Notice .

12. Install the connecting rod bearing cap bolts.

**Tighten:** Tighten the connecting rod bearing cap bolts to 27 N.m (20 lb ft) plus 50 degrees using **J 45059**. See Special Tools.

13. Pry the connecting rod back and forth and check for binding. If necessary, loosen and retighten the connecting rod bearing cap.



**Fig. 455: Measuring Connecting Side Clearance**  
Courtesy of GENERAL MOTORS CORP.

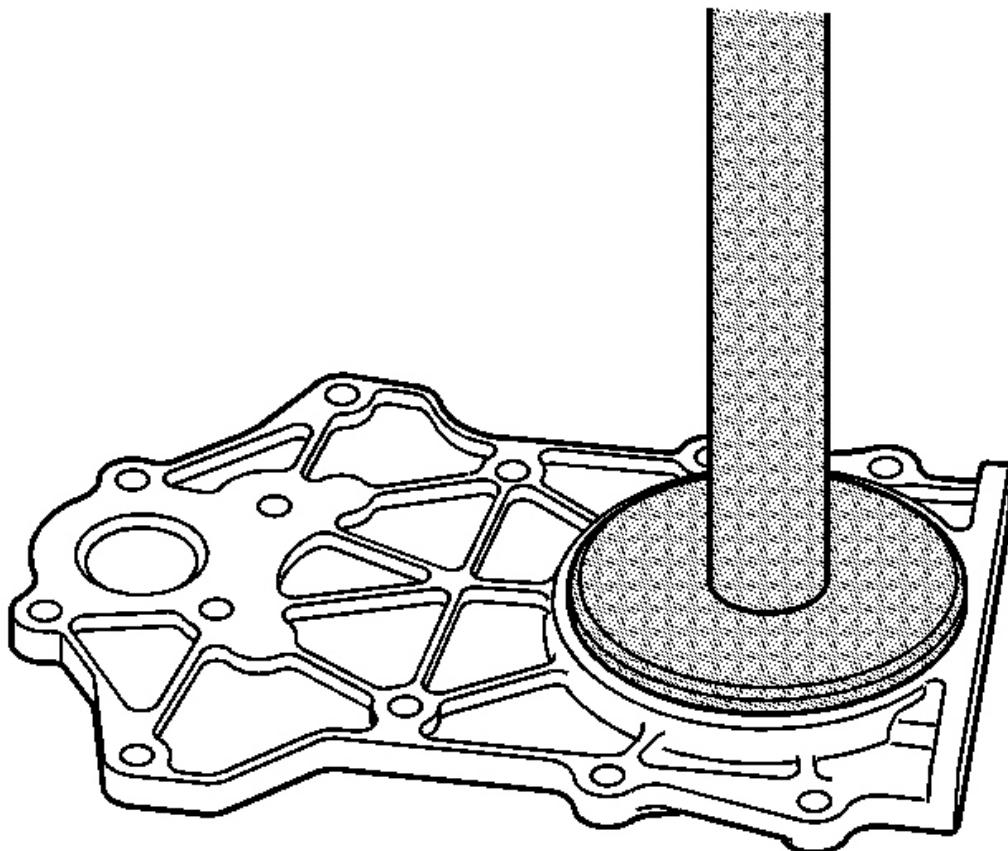
14. Measure the connecting rod side clearance.

#### CRANKSHAFT REAR OIL SEAL AND HOUSING INSTALLATION (SECOND DESIGN)

##### Tools Required

- **EN-47623** Rear Main Seal Installer. See Special Tools.
- **J 8092** Drive Handle
- **J 45059** Angle Meter. See Special Tools.

**Installation Procedure**



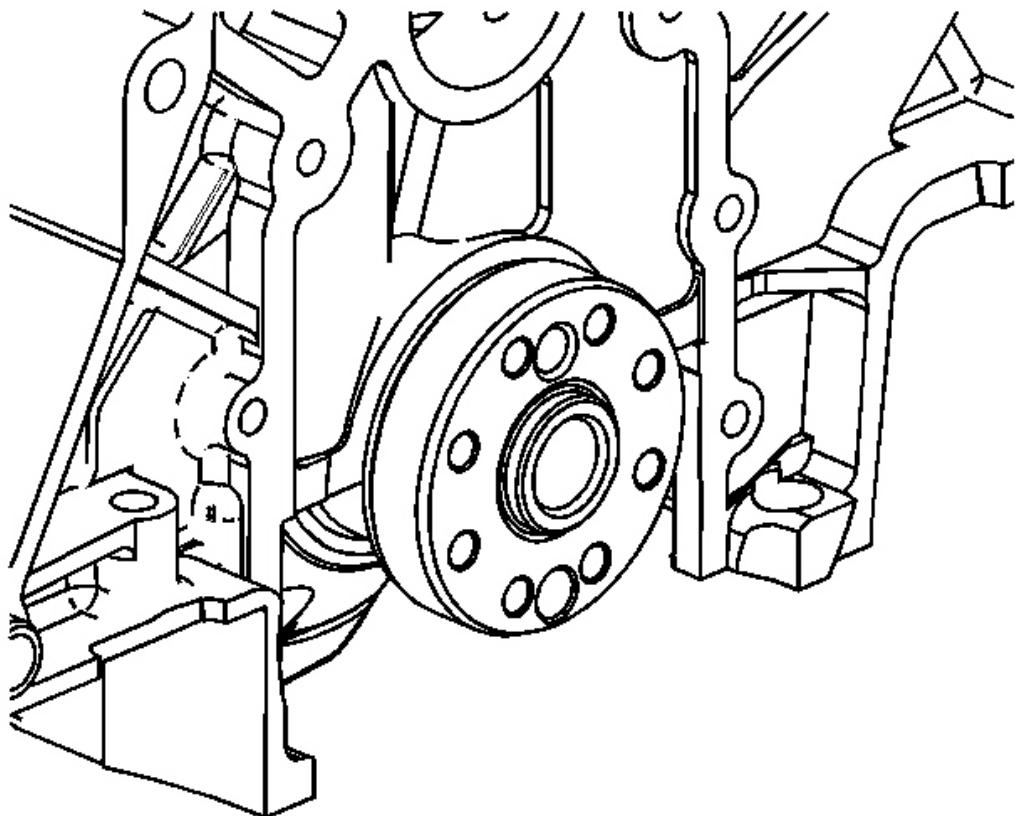
**Fig. 456: Installing Crankshaft Rear Oil Seal**

Courtesy of GENERAL MOTORS CORP.

**NOTE:** Do not apply or use any oil lubrication on the crankshaft rear oil seal or the seal installer. Do not touch the sealing lip of the oil seal once the protective sleeve is removed. Doing so will damage/deform the seal.

**NOTE: Clean the crankshaft sealing surface with a clean, lint free towel. Inspect lead-in edge of crankshaft for burrs/sharp edges that could damage the rear main oil seal. Remove burrs/sharp edges with crocus cloth before proceeding.**

1. Clean and inspect the crankshaft rear oil seal housing making sure it is free of any foreign material.
2. With all bolts removed from the housing, place it face up on a flat clean surface.
3. Carefully remove protection sleeve from the new rear oil seal assembly.
4. Install the seal onto **EN-47623** by placing the seal on an angle and using a twisting motion until it is fully seated. See **Special Tools**.
5. Place **EN-47623** along with **J 8092** onto the housing as shown and apply a constant downward force until the seal is fully seated.



**Fig. 457: View Of Crankshaft Sealing Surface**

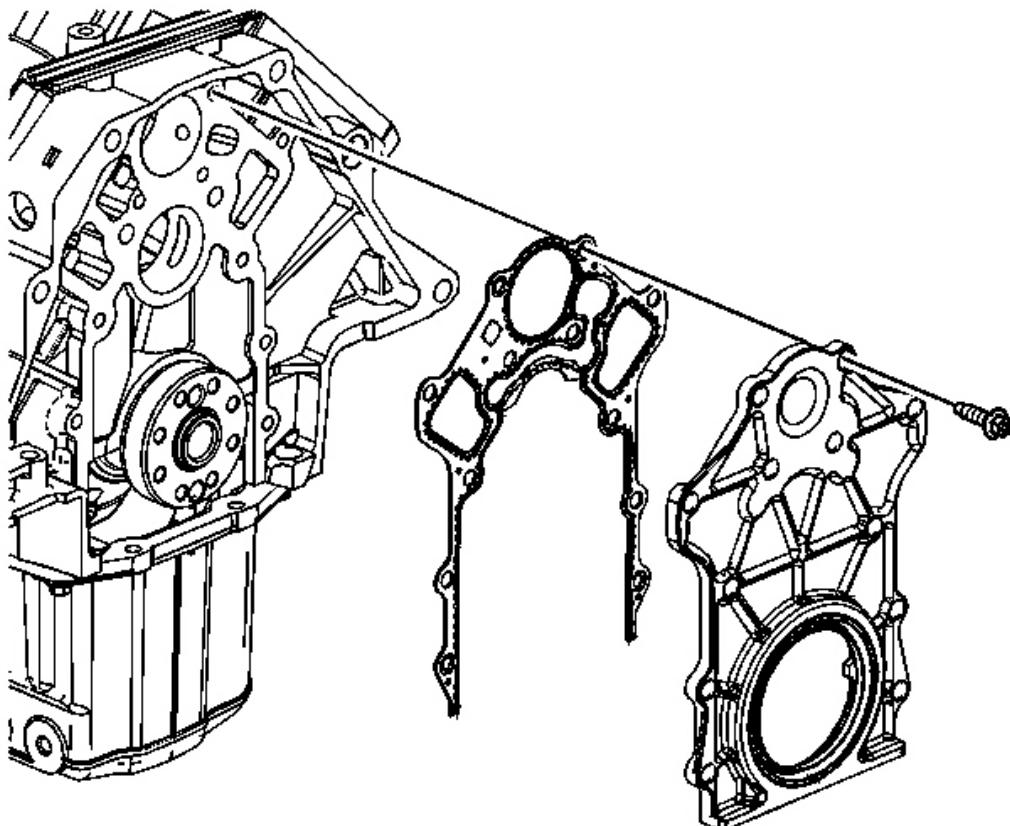
Courtesy of GENERAL MOTORS CORP.

6. Clean the crankshaft sealing surface with a clean, lint free towel. Inspect the crankshaft sealing surface and leading edge of the crankshaft for burrs/sharp edges that could damage the rear main oil seal. Remove any burrs or sharp edges with crocus cloth before proceeding.

**NOTE: Do not use a sealant or adhesive when installing this component. Use of a sealant or adhesive can cause improper sealing. A component that is not sealed properly can leak leading to extensive engine damage.**

**IMPORTANT: Always install a new crankshaft rear oil seal housing gasket.**

7. Install a new crankshaft rear oil seal housing gasket and the housing onto the engine.



**Fig. 458: Crankshaft Rear Oil Seal & Housing (Second Design)**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** The plastic inserts found on the rear oil seal housing retaining bolts are used to aid production assembly only. The inserts are not required for service.

8. Install the crankshaft rear oil seal housing gasket and housing.
9. Install the crankshaft rear oil seal housing bolts.

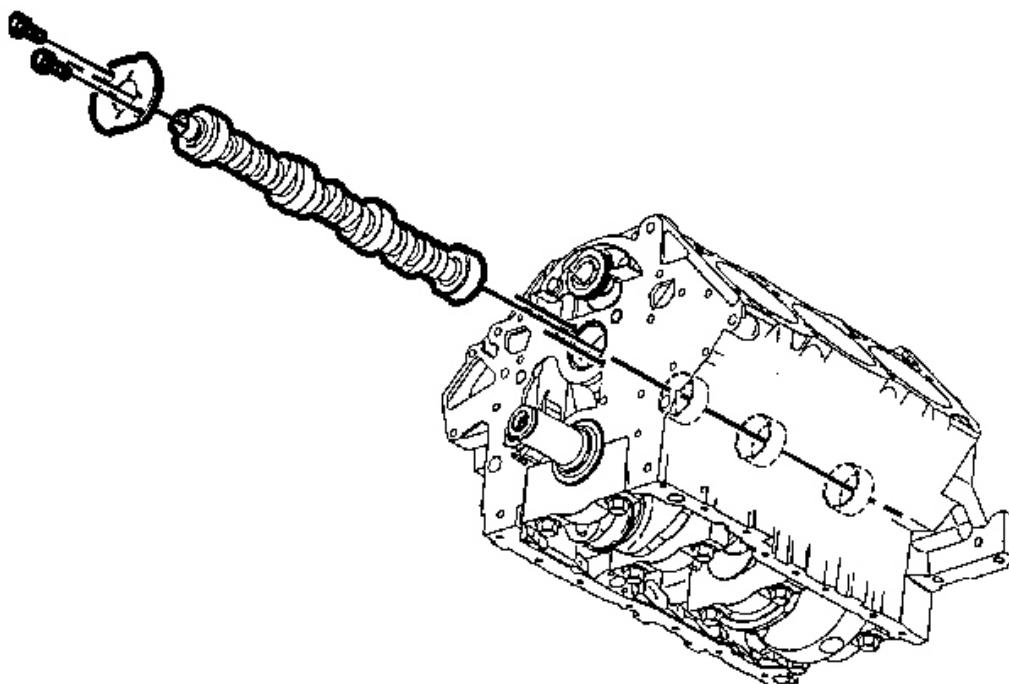
**NOTE:** Refer to Fastener Notice .

10. Tighten the crankshaft rear oil seal housing bolts.

**Tighten:** Tighten the crankshaft rear oil seal housing bolts to 15 N.m (11 lb ft). Use **J 45059** to tighten the bolts an additional 50 degrees. See **Special Tools**.

## CAMSHAFT INSTALLATION

### Installation Procedure



**Fig. 459: Installing Camshaft**

Courtesy of GENERAL MOTORS CORP.

1. Coat the camshaft with prelube GM P/N 12345501 (Canadian P/N 992704) or the equivalent.
2. Install the camshaft.
3. Install the camshaft thrust plate.

**NOTE: Refer to Fastener Notice .**

4. Install the camshaft thrust plate bolts.

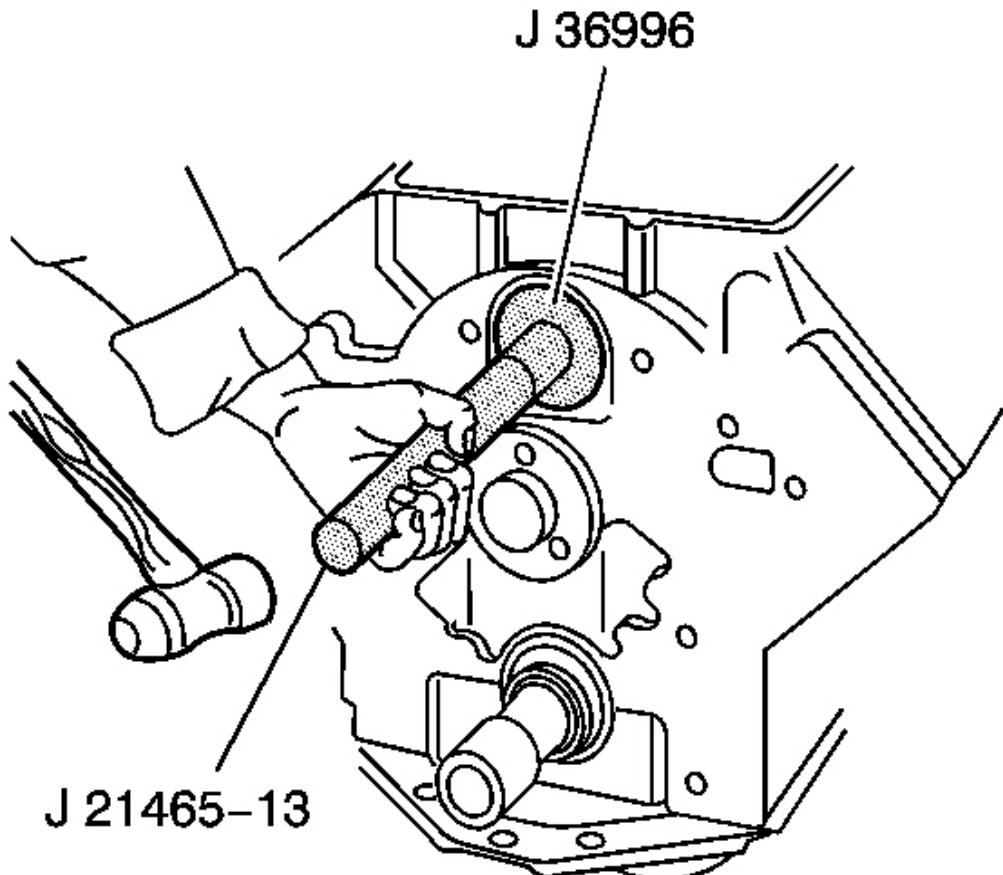
**Tighten:** Tighten the bolts to 15 N.m (11 lb ft).

## BALANCE SHAFT INSTALLATION

### Tools Required

- **J 8001** Dial Indicator Set. See [Special Tools](#).
- **J 21465-13** Drive Handle Extension. See [Special Tools](#).
- **J 36996** Balance Shaft Installer. See [Special Tools](#).
- **J 45059** Angle Meter. See [Special Tools](#).

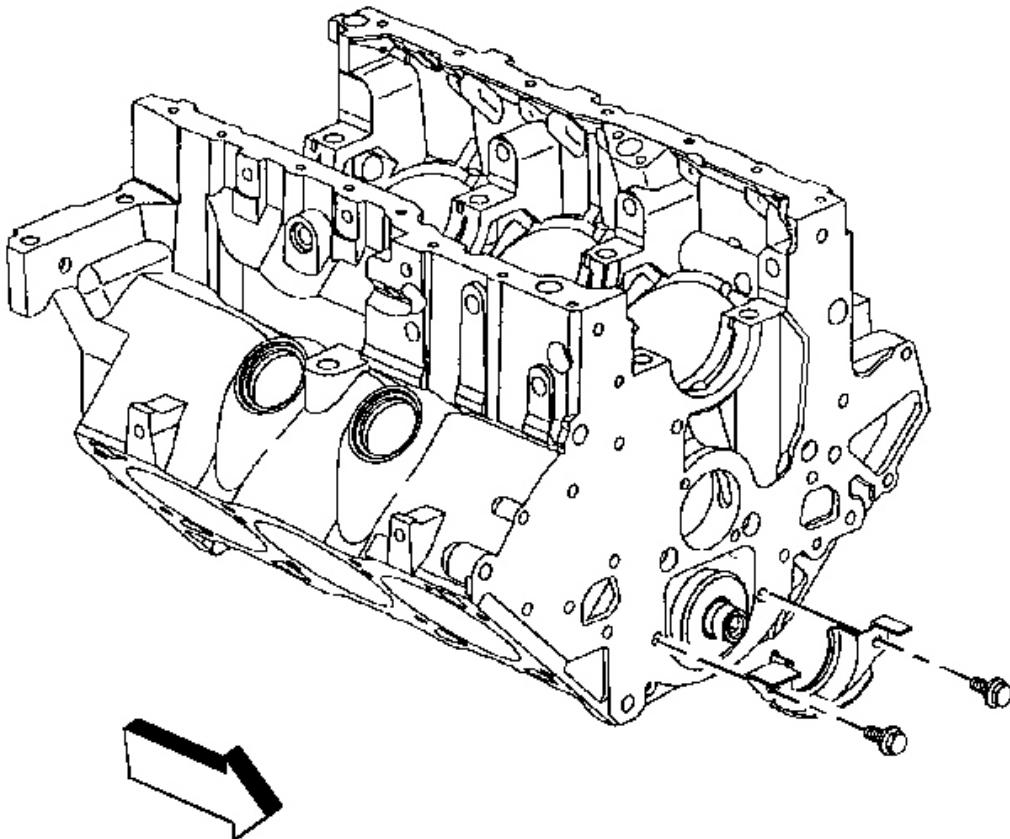
### Installation Procedure



**Fig. 460: Installing Balance Shaft**

Courtesy of GENERAL MOTORS CORP.

1. Use **J 21465-13** and **J 36996** to install the balance shaft into the engine block. See **Special Tools**.



**Fig. 461: View Of Balance Shaft Retainer**

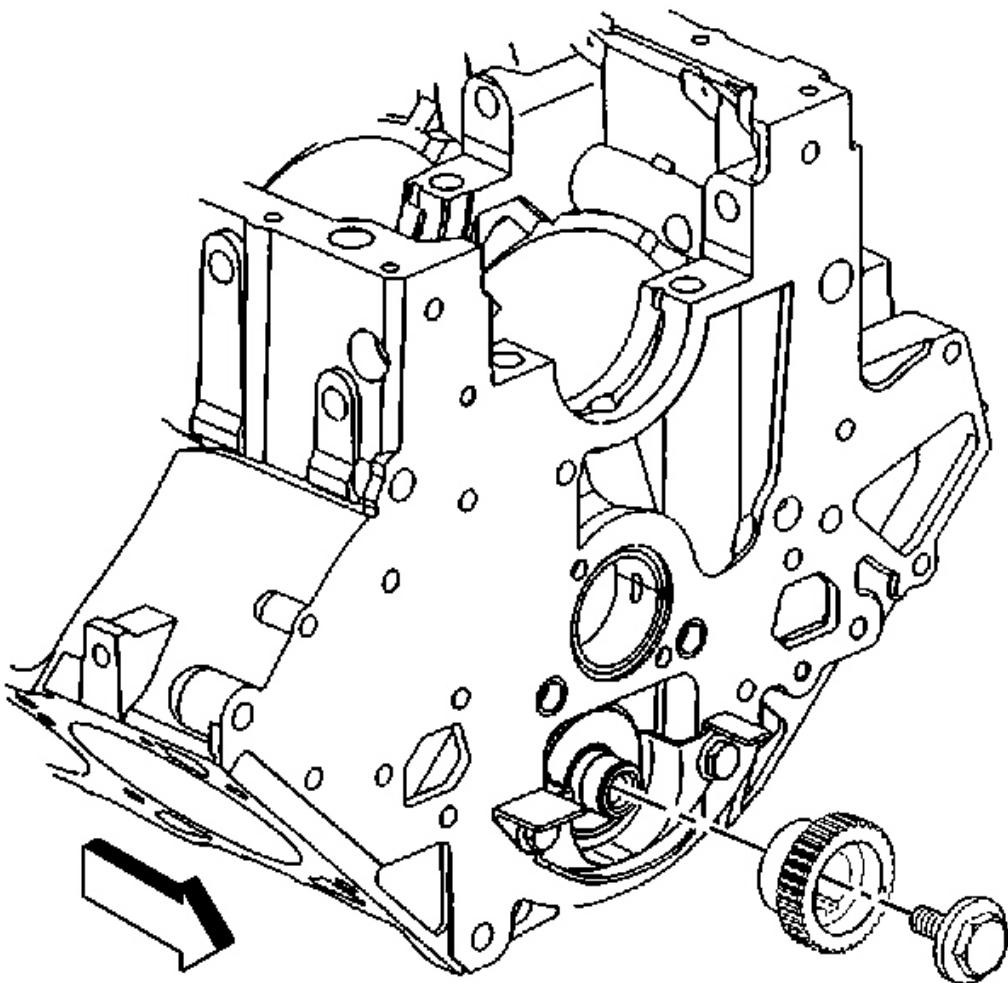
Courtesy of GENERAL MOTORS CORP.

2. Install the balance shaft retainer.

**NOTE: Refer to Fastener Notice .**

3. Install the balance shaft retainer bolts.

**Tighten:** Tighten the balance shaft retainer bolts to 30 N.m (22 lb ft).



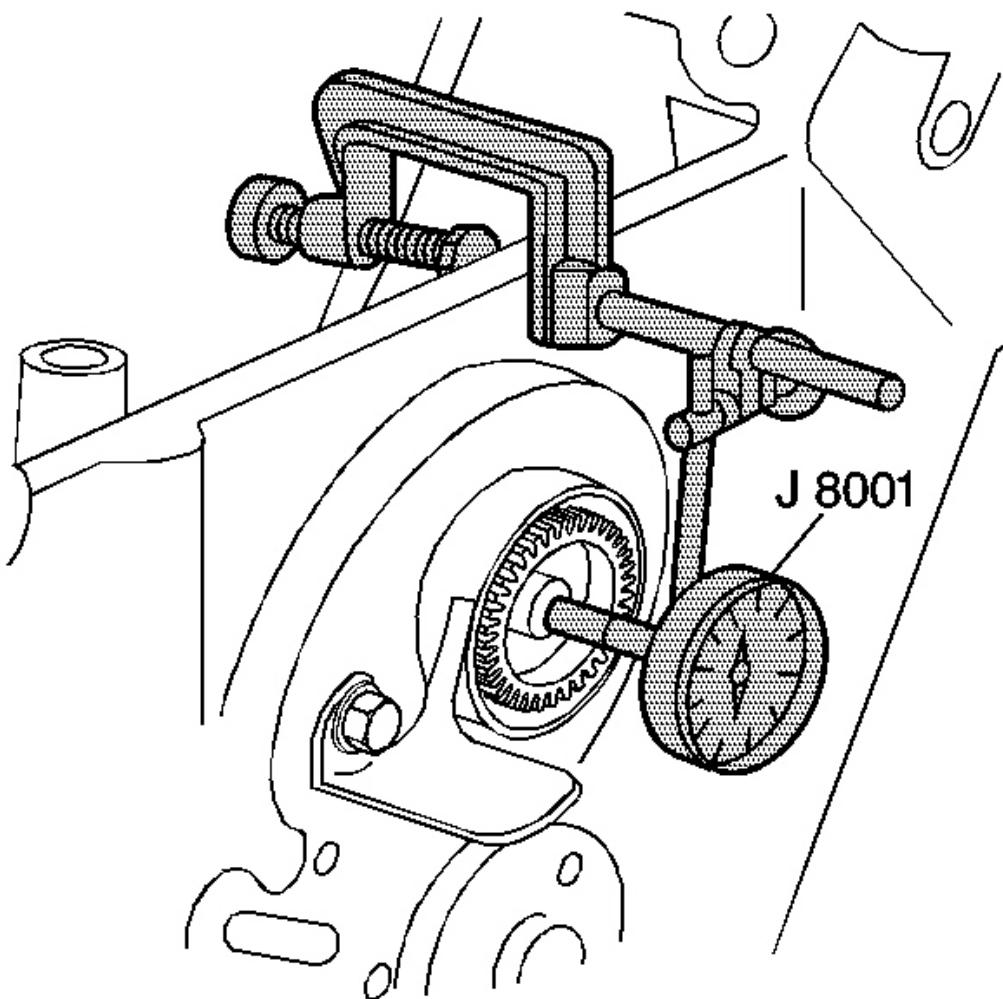
**Fig. 462: Locating Balance Shaft Driven Gear & Bolt**  
Courtesy of GENERAL MOTORS CORP.

4. Install the balance shaft driven gear.

**NOTE:** Refer to SPECIAL FASTENER NOTICE .

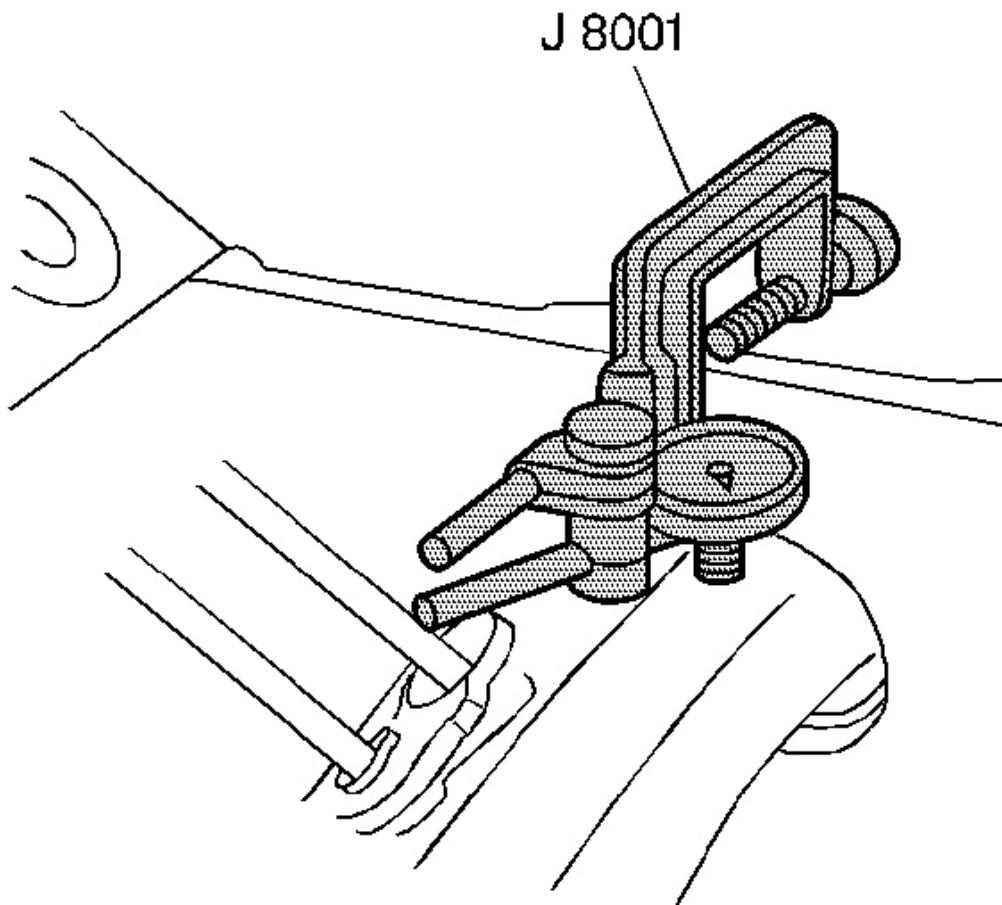
5. Install the balance shaft driven gear bolt.

**Tighten:** Tighten the balance shaft driven gear bolt to 22 N.m (16 lb ft). Use **J 45059** to tighten the bolt an additional 70 degrees. See **Special Tools**.



**Fig. 463: Measuring Balance Shaft End Play**  
Courtesy of GENERAL MOTORS CORP.

6. Using **J 8001** measure the balance shaft end play. See **Special Tools**. End play must not exceed 0.028 mm (0.008 in).

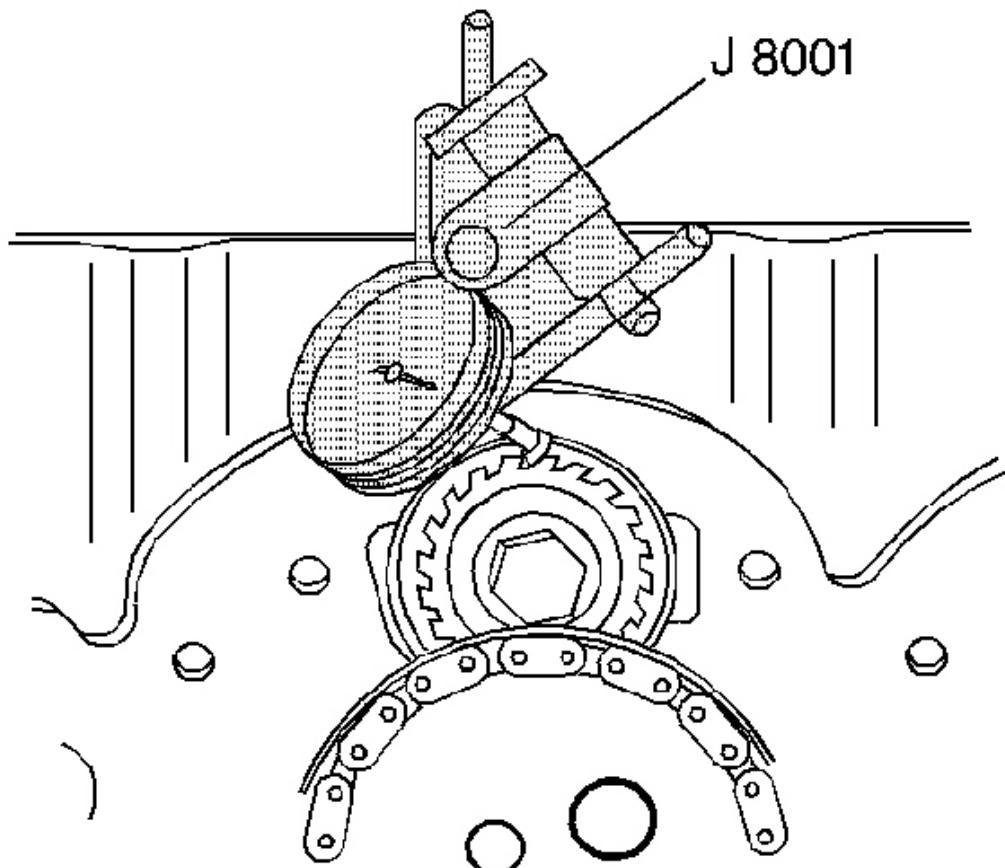


**Fig. 464: Measuring Balance Shaft Radial Play**

Courtesy of GENERAL MOTORS CORP.

7. Using **J 8001** measure the balance shaft radial play at the rear. See **Special Tools**. Radial play must be between 0.0127-0.119 mm (0.0005-0.0047 in).
8. Install the balance shaft drive gear.
9. Install the camshaft sprocket.
10. Turn the camshaft so the timing mark on the camshaft sprocket is straight down.
11. Remove the camshaft sprocket and balance shaft drive gear.
12. Turn the balance shaft so the timing mark on the balance shaft driven gear points straight down.

13. Partially install the balance shaft drive gear so the gear teeth are not engaged.
14. Align the marks on the balance shaft driven gear and the balance shaft drive gear. Do this by turning the balance shaft.
15. Once marks are aligned, fully seat balance shaft drive gear and engage gear teeth.
16. Turn the crankshaft so the number one piston is at top dead center.
17. Install the timing chain and camshaft sprocket.



**Fig. 465: Measuring Balance Shaft Gear Lash**  
Courtesy of GENERAL MOTORS CORP.

18. Using **J 8001** measure the gear lash at four places. See **Special Tools**. Measure every quarter turn. Gear lash must be between 0.050-0.127 mm (0.002-0.005 in).

## 2006 Buick Lucerne CXS

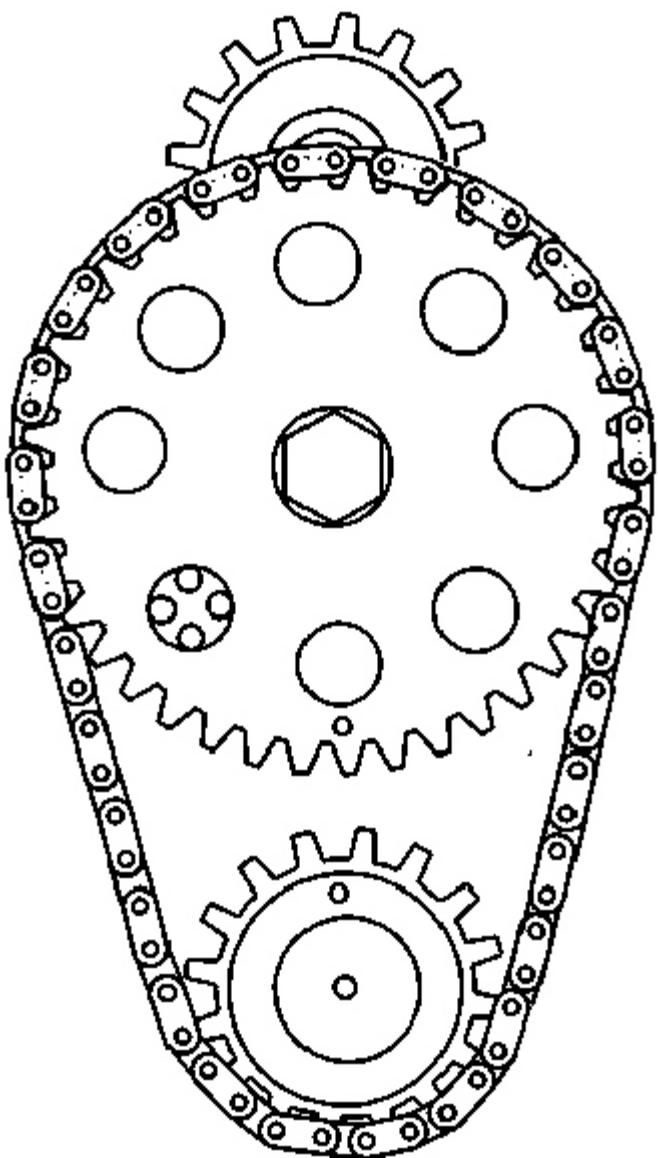
2006 ENGINE Engine Mechanical - 3.8L - Lucerne

### TIMING CHAIN AND SPROCKETS INSTALLATION

#### Tools Required

**J 45059** Angle Meter. See [Special Tools](#).

#### Installation Procedure

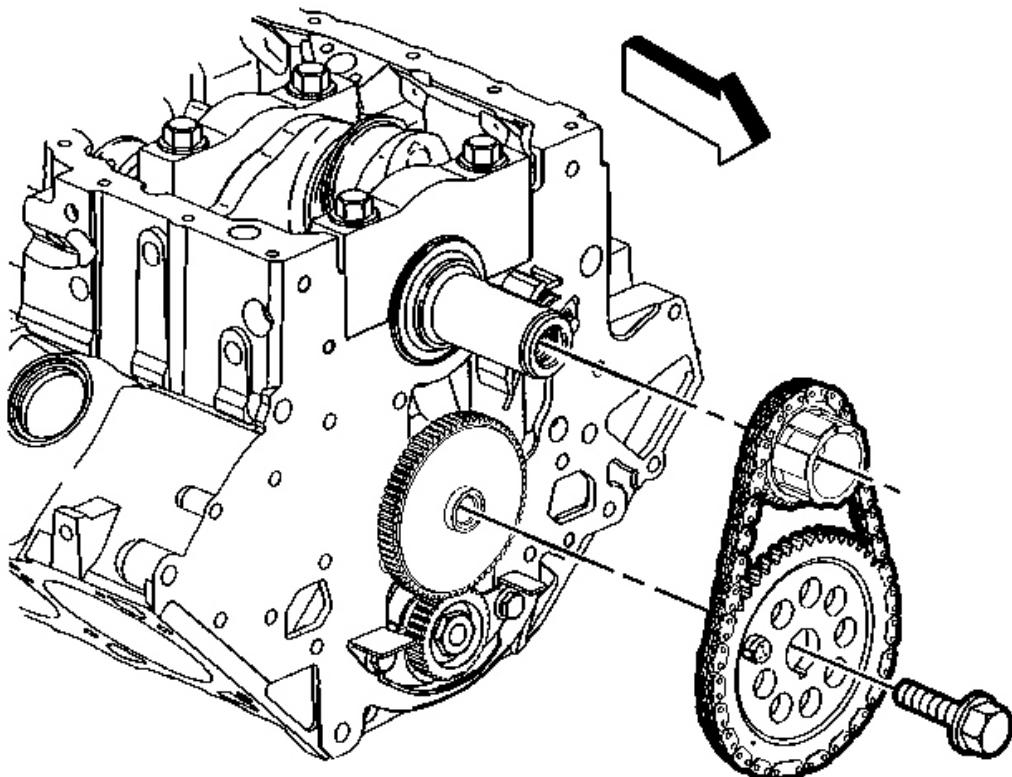


**Fig. 466: Aligning The Timing Marks**  
Courtesy of GENERAL MOTORS CORP.

1. Install the crankshaft balancer key into the crankshaft keyway.

The crankshaft balancer key should be parallel to the crankshaft or with a slight incline.

2. Install the timing chain on the sprockets. Align the timing marks.



**Fig. 467: Timing Chain, Crankshaft Sprocket & Camshaft Sprocket (L26)**  
Courtesy of GENERAL MOTORS CORP.

3. Install the timing chain, the crankshaft sprocket and the camshaft sprocket.

**NOTE:** Refer to Special Fastener Notice .

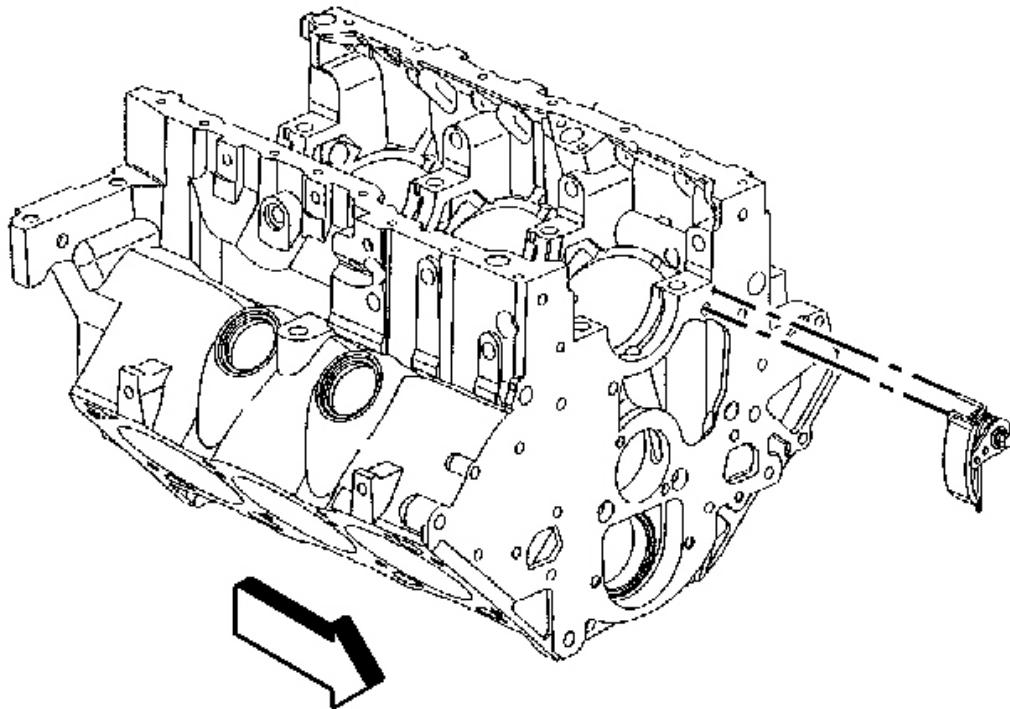
**NOTE:** Refer to Fastener Notice .

4. Install the camshaft sprocket bolt.

**Tighten:** Tighten the camshaft sprocket bolt to 100 N.m (74 lb ft). Use **J 45059** to tighten the camshaft sprocket bolt an additional 90 degrees. See Special Tools.

## 2006 Buick Lucerne CXS

2006 ENGINE Engine Mechanical - 3.8L - Lucerne



**Fig. 468: View Of Timing Chain Dampener**  
Courtesy of GENERAL MOTORS CORP.

5. Install the timing chain dampener.

**Tighten:** Tighten the timing chain dampener bolt to 22 N.m (16 lb ft).

### ENGINE FRONT COVER INSTALLATION

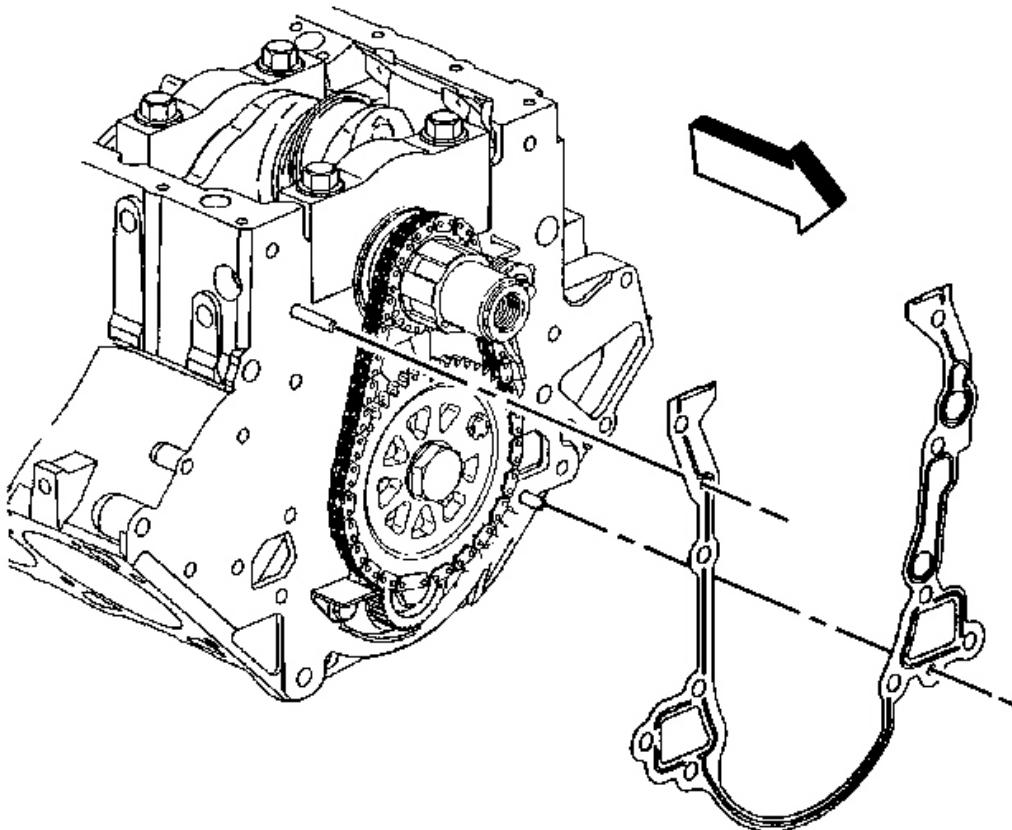
#### Tools Required

**J 45059** Angle Meter. See [Special Tools](#).

#### Installation Procedure

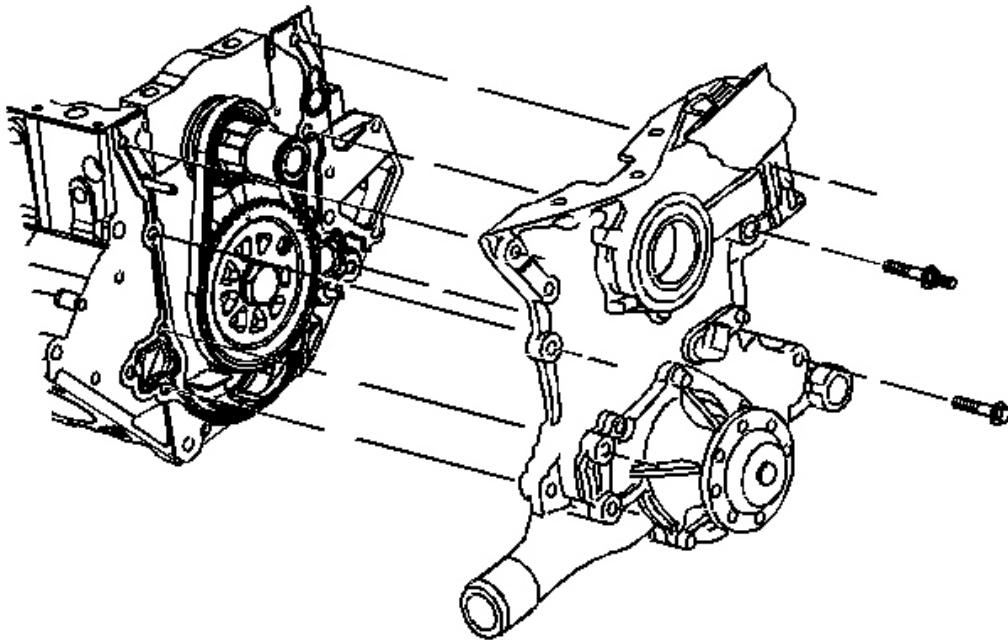
**2006 Buick Lucerne CXS**

2006 ENGINE Engine Mechanical - 3.8L - Lucerne



**Fig. 469: Locating Engine Front Cover Gasket**  
Courtesy of GENERAL MOTORS CORP.

1. Install the engine front cover gasket.



**Fig. 470: View Of Engine Front Cover**  
Courtesy of GENERAL MOTORS CORP.

2. Install the engine front cover.

Align the cogs on the crankshaft sprocket with the cogs on the oil pump in the engine front cover.

3. Apply sealant GM P/N 12346004 (Canadian P/N 10953480) or the equivalent to the engine front cover bolt threads.

**NOTE:** Refer to Fastener Notice .

4. Install the engine front cover bolts.

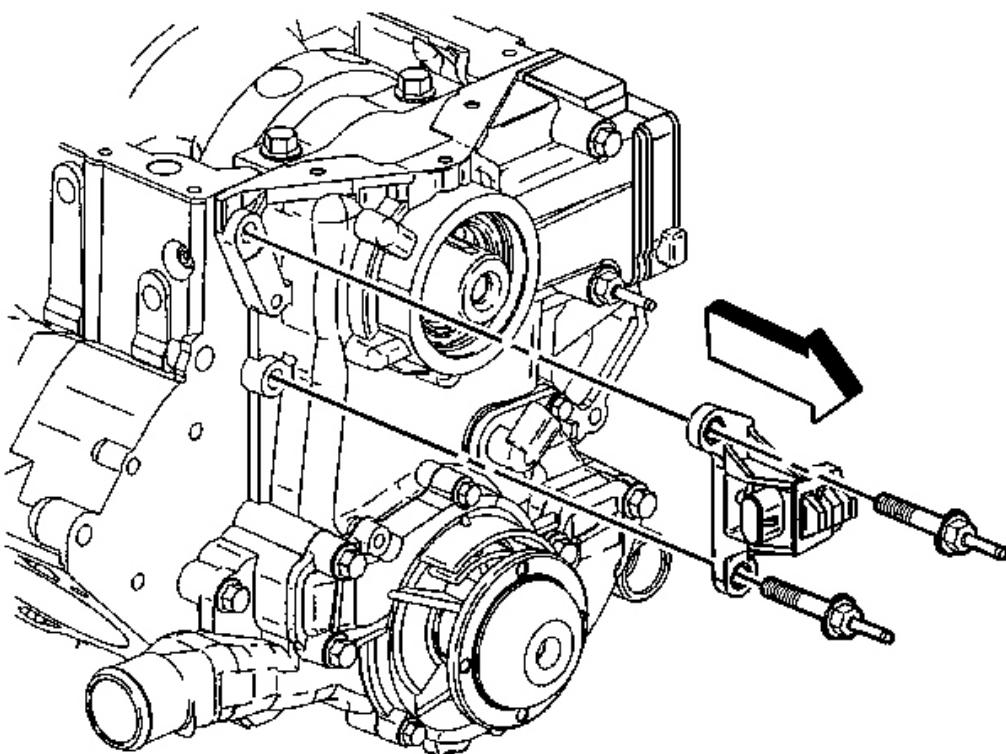
**Tighten:** Tighten the engine front cover bolts to 20 N.m (15 lb ft). Use the **J 45059** to tighten the engine front cover bolts an additional 40 degrees. See Special Tools.

5. Install the oil pan to engine front cover bolts.

**Tighten:** Tighten the oil pan bolts to 14 N.m (125 lb in).

6. Install the oil filter.

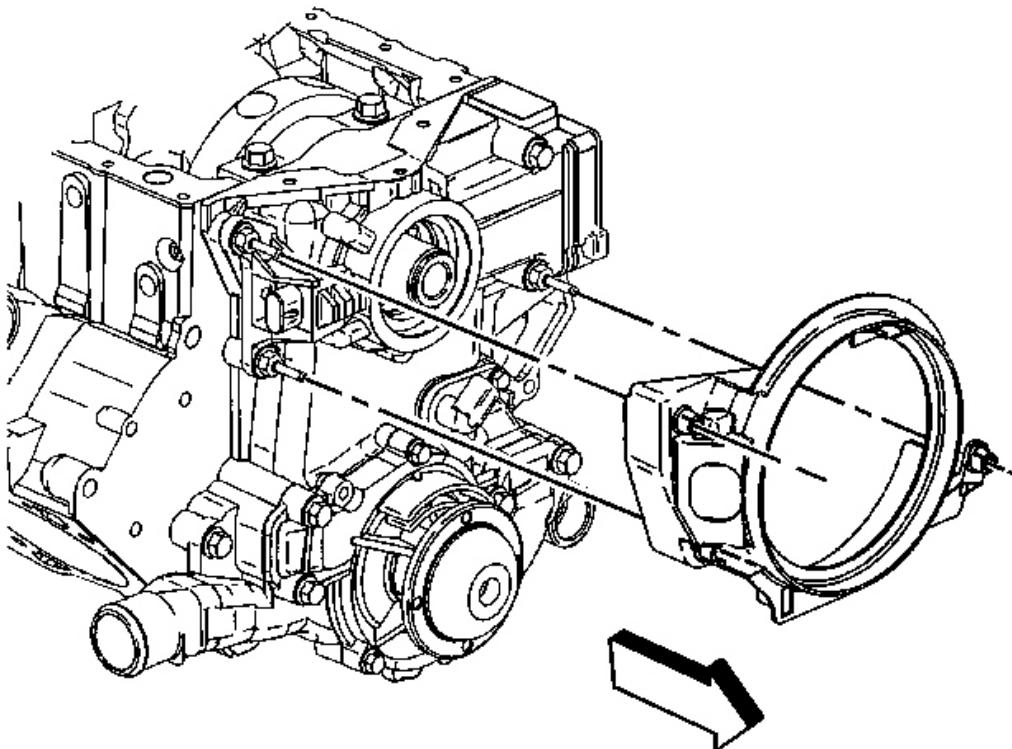
**Tighten:** Tighten the oil filter to 30 N.m (22 lb ft).



**Fig. 471: Locating Crankshaft Position Sensor**  
Courtesy of GENERAL MOTORS CORP.

7. Install the crankshaft position (CKP) sensor.

**Tighten:** Tighten the CKP sensor studs to 30 N.m (22 lb ft).



**Fig. 472: Locating Crankshaft Position Sensor Shield**  
Courtesy of GENERAL MOTORS CORP.

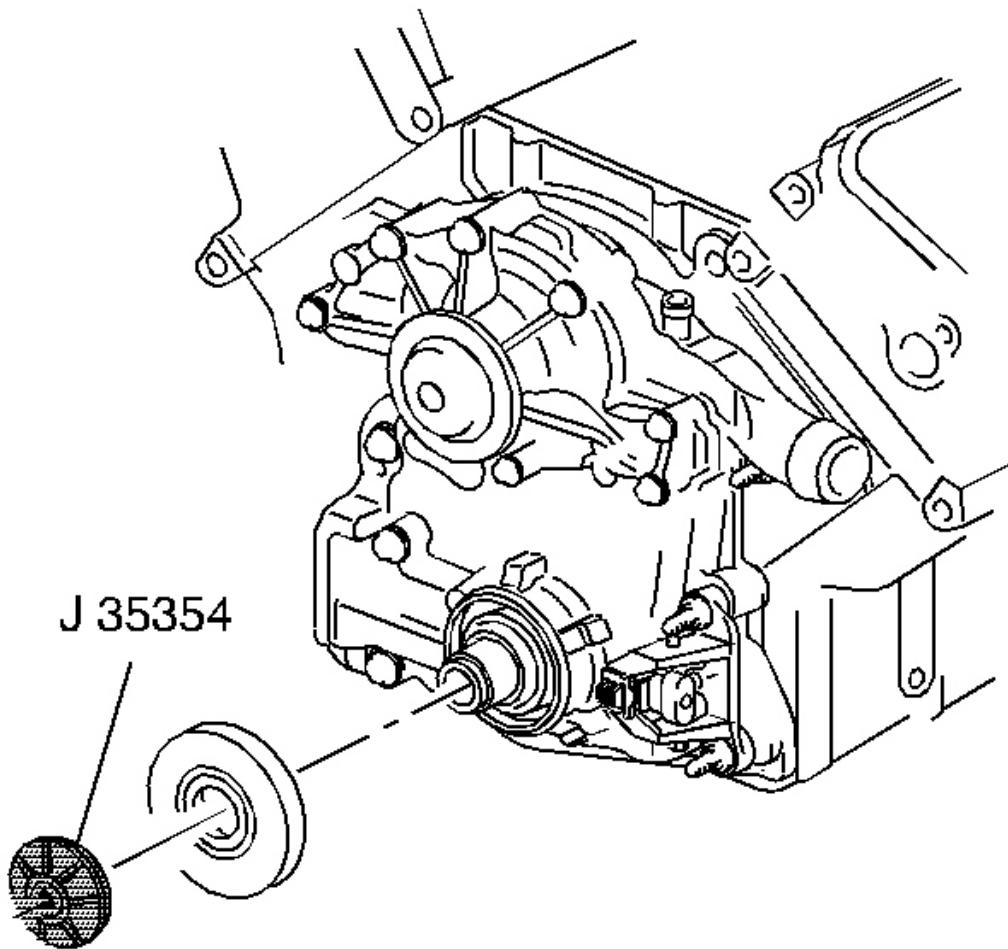
8. Install the CKP sensor shield.

#### CRANKSHAFT FRONT OIL SEAL INSTALLATION

##### Tools Required

**J 35354** Seal Installer. See [Special Tools](#).

##### Installation Procedure



**Fig. 473: Installing Crankshaft Front Oil Seal**  
Courtesy of GENERAL MOTORS CORP.

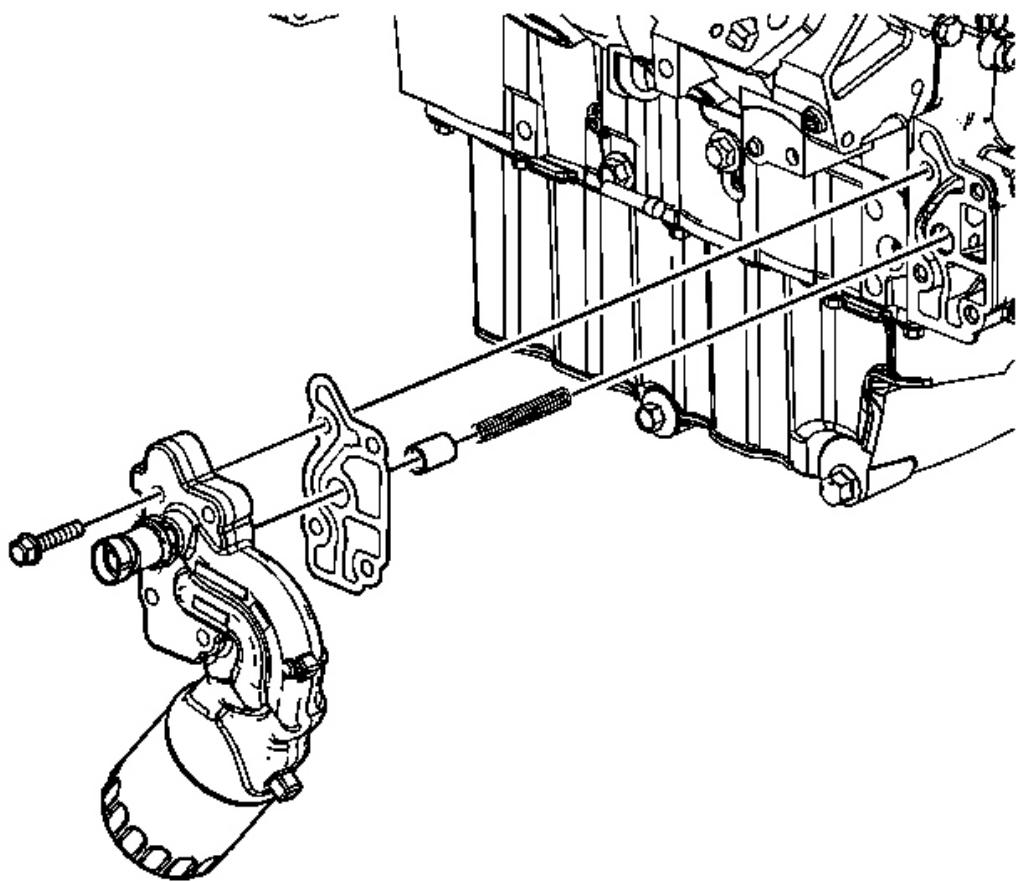
1. Coat the inside diameter of the crankshaft front oil seal with lubricant GM P/N 12345616 (Canadian P/N 993182) or the equivalent.
2. Use **J 35354** and a soft faced hammer to install the crankshaft front oil seal. See **Special Tools**.
3. Remove **J 35354**. See **Special Tools**.

#### OIL FILTER ADAPTER INSTALLATION

##### Tools Required

**J 45059** Angle Meter. See Special Tools.

**Installation Procedure**



**Fig. 474: Identifying Oil Filter Adapter**  
Courtesy of GENERAL MOTORS CORP.

1. Install the oil pressure relief valve spring into the engine front cover.
2. Install the oil pressure relief valve into the engine front cover.
3. Install a new oil filter adapter gasket.
4. Install the oil filter adapter.

**NOTE:** Refer to Fastener Notice .

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5. Install the oil filter adapter bolts.

**Tighten:** Tighten the oil filter adapter bolts to 15 N.m (11 lb ft).

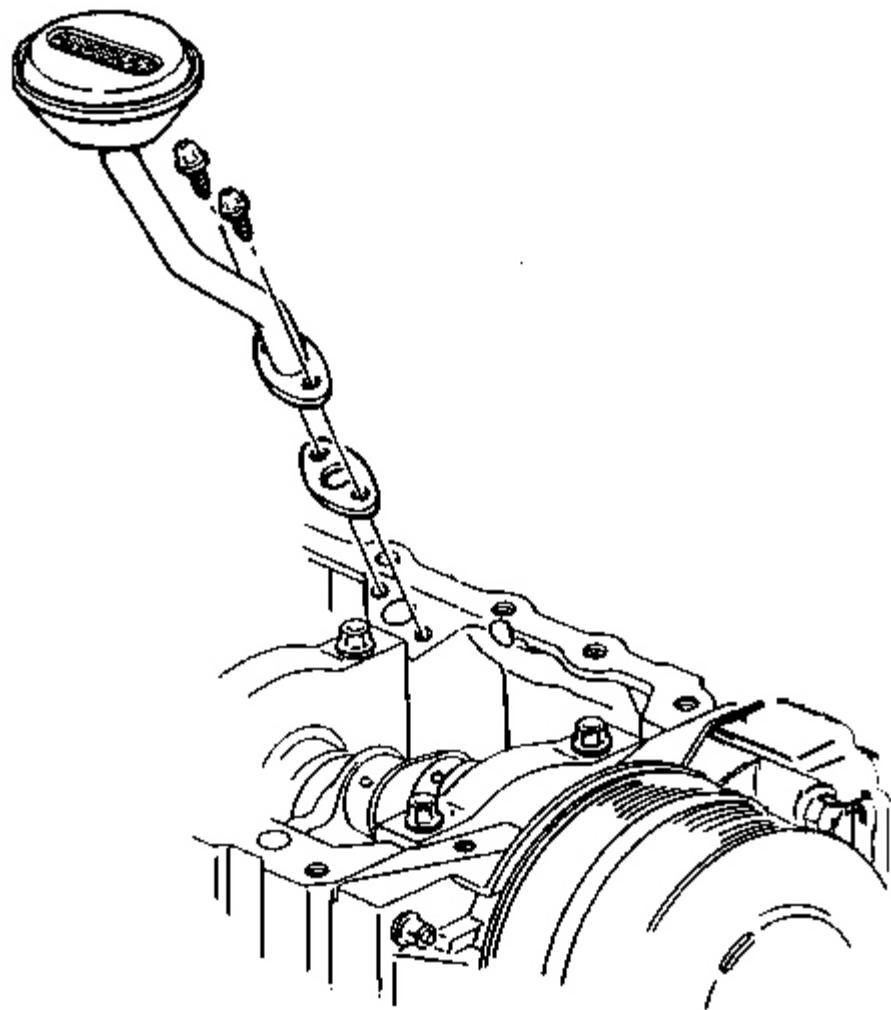
Using **J 45059** rotate each bolt an additional 50 degrees. See **Special Tools**.

6. Install the oil filter.

**Tighten:** Tighten the oil filter to 30 N.m (22 lb ft).

## OIL PUMP SUCTION PIPE AND SCREEN ASSEMBLY INSTALLATION

### Installation Procedure



**Fig. 475: View Of Oil Pump Pipe & Screen Assembly**  
Courtesy of GENERAL MOTORS CORP.

1. Install the oil pump pipe and screen assembly gasket.

**IMPORTANT: The oil pan gasket must be installed before the oil pump pipe and screen assembly.**

2. Install the oil pan gasket.

3. Install the oil pump pipe and screen assembly.

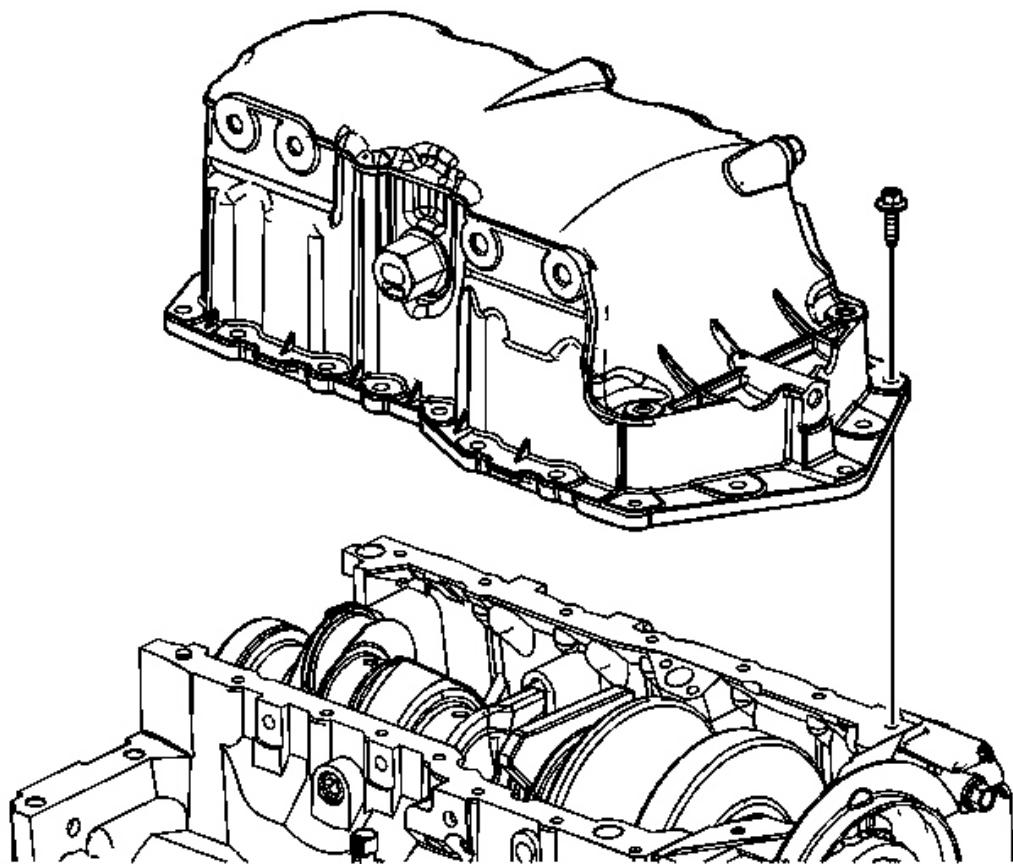
**NOTE:** Refer to Fastener Notice .

4. Install the oil pump pipe and screen assembly bolts.

**Tighten:** Tighten the bolts to 15 N.m (11 lb ft).

## OIL PAN INSTALLATION

### Installation Procedure



**Fig. 476: View Of Oil Pan & Bolts**

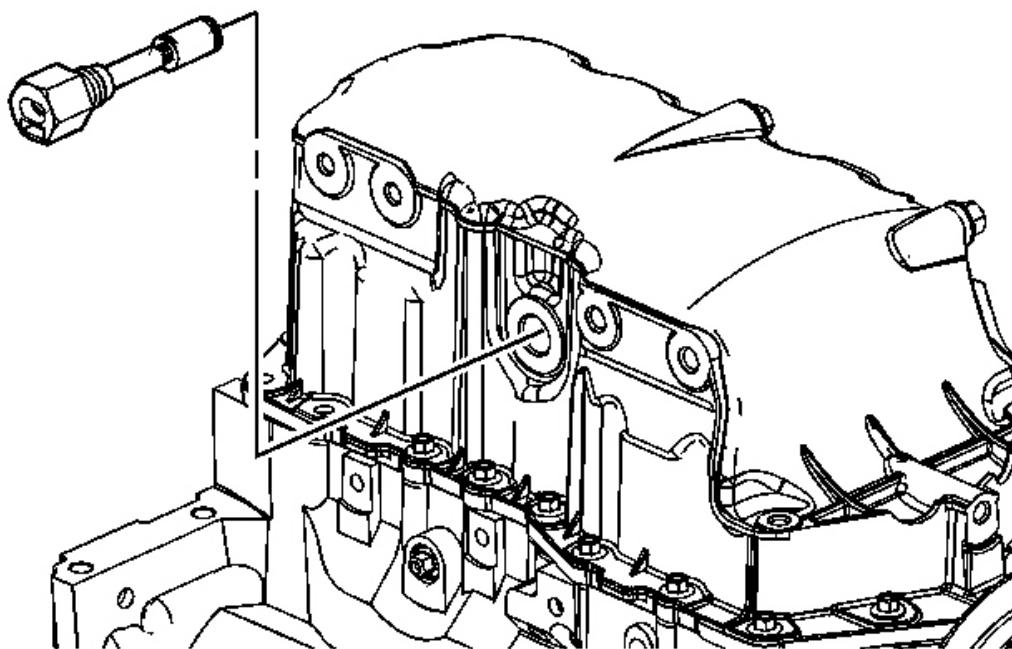
Courtesy of GENERAL MOTORS CORP.

1. Apply a continuous bead 3.0 mm (0.19 in) thick of RTV GM P/N 12378521 (Canadian P/N 88901148) or equivalent to the oil pan flange on the block as well as an additional drop to all four corners of the block where the front and rear covers meet.
2. Install the oil pan.
3. Clean the oil pan bolts.
4. Apply one drop of GM P/N 12345382 (Canadian P/N 10953489), to each bolt.

**NOTE:** Refer to Fastener Notice .

5. Install the oil pan bolts.

**Tighten:** Tighten the bolts to 14 N.m (10 lb ft).



**Fig. 477: Identifying Oil Level Sensor**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Install the oil level sensor, located in the oil pan, after the oil pan is installed. The sensor may be damaged if the oil level

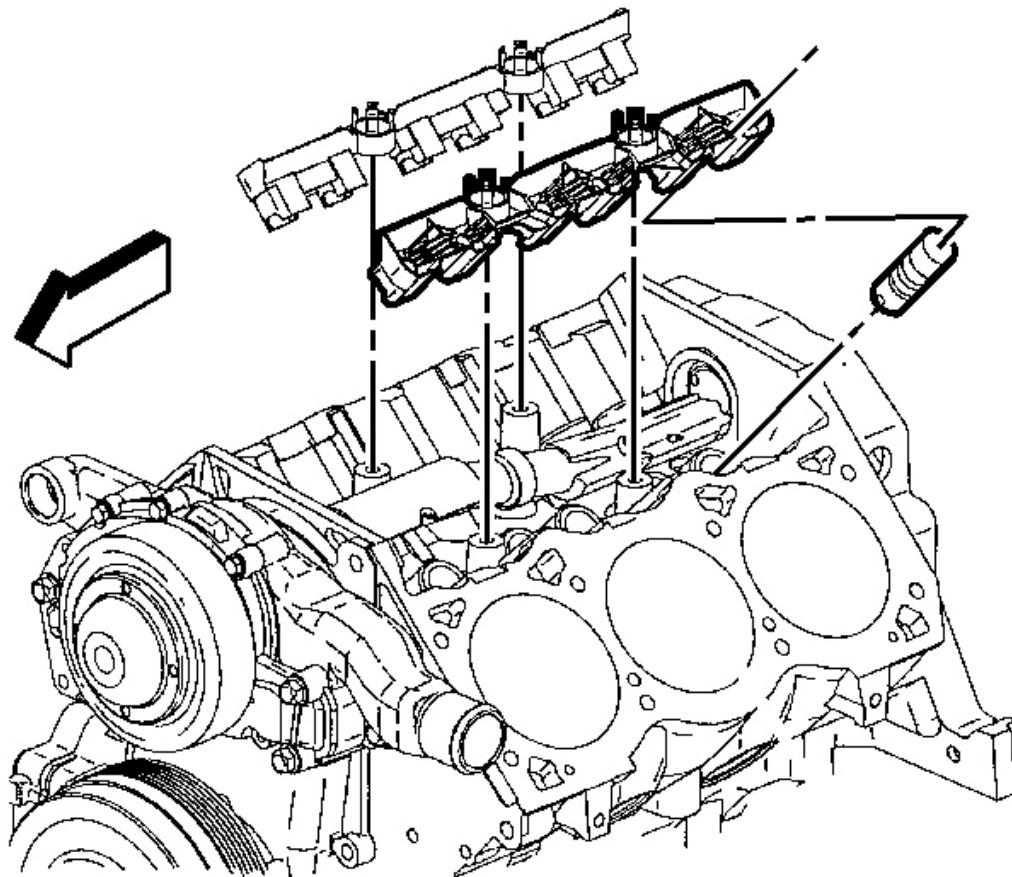
**sensor is installed first.**

6. Install the oil level sensor.

**Tighten:** Tighten the oil level sensor to 20 N.m (15 lb ft).

## VALVE LIFTER INSTALLATION

### Installation Procedure



**Fig. 478: Removing/Installing Valve Lifters & Guides**  
Courtesy of GENERAL MOTORS CORP.

1. Dip the valve lifters in prelube GM P/N 12345501 (Canadian 992704) or the equivalent.

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2. Install the valve lifters.
3. Install the valve lifter guides.

**NOTE:** Refer to Fastener Notice .

4. Install the valve lifter guide bolts.

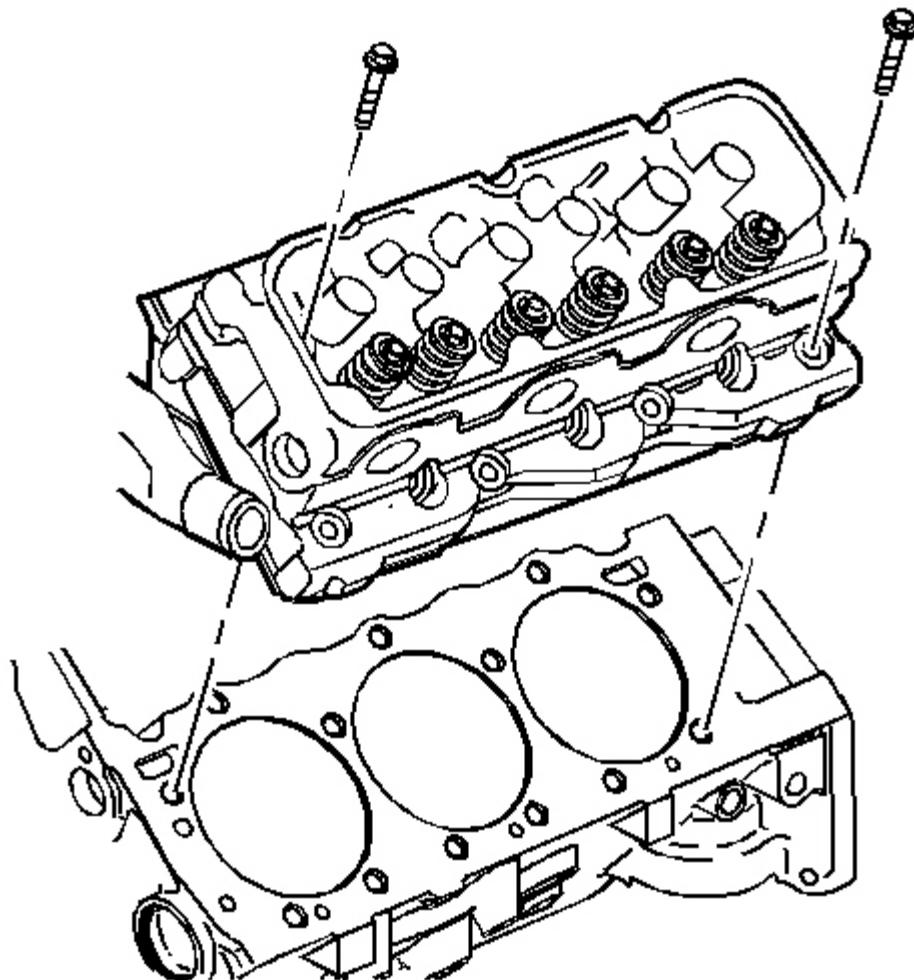
**Tighten:** Tighten the valve lifter guide bolts to 30 N.m (22 lb ft).

### CYLINDER HEAD INSTALLATION - RIGHT SIDE

#### Tools Required

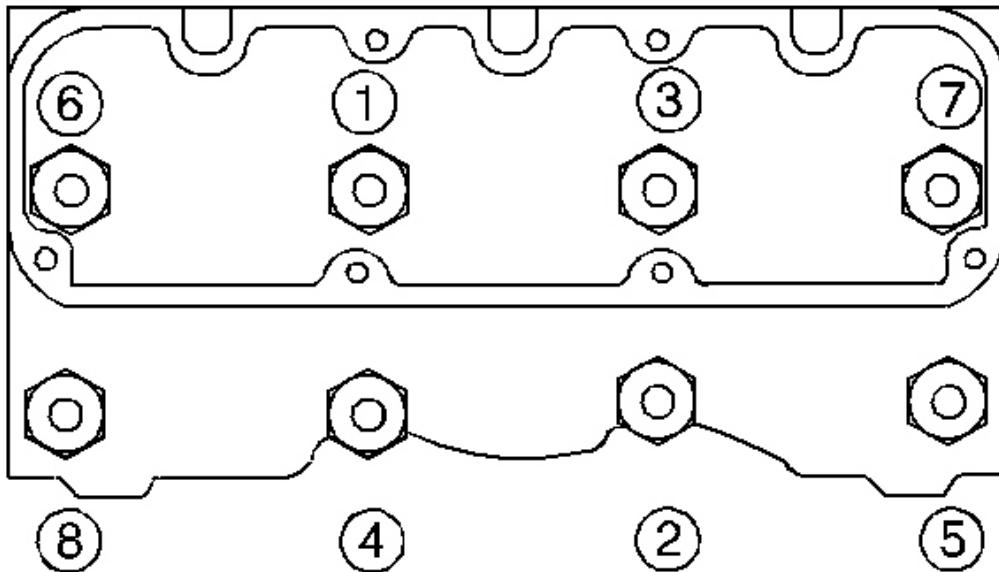
**J 45059** Angle Meter. See Special Tools.

#### Installation Procedure



**Fig. 479: Identifying Cylinder Head & Cylinder Head Bolts**  
Courtesy of GENERAL MOTORS CORP.

1. Install the cylinder head gasket. Ensure the arrows point towards the front of the engine. The right cylinder head gasket has the letter R stamped next to the arrow.
2. Install the cylinder head.



**Fig. 480: Identifying Cylinder Head Bolt Tightening Sequence**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Refer to SPECIAL FASTENER NOTICE .

**NOTE:** Refer to Fastener Notice .

3. Install new cylinder head bolts.

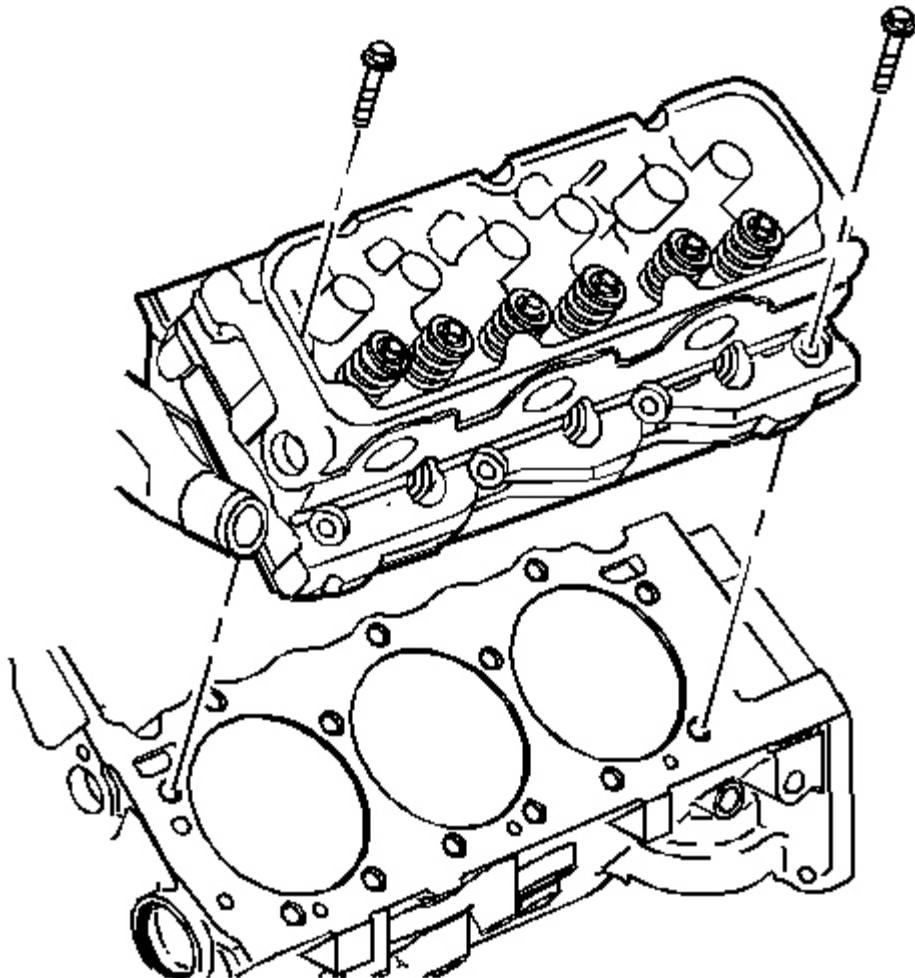
**Tighten:** Tighten the cylinder head bolts to 50 N.m (37 lb ft) in sequence. Using **J 45059** rotate each cylinder head bolt an additional 120 degrees. See Special Tools.

#### **CYLINDER HEAD INSTALLATION - LEFT SIDE**

**Tools Required**

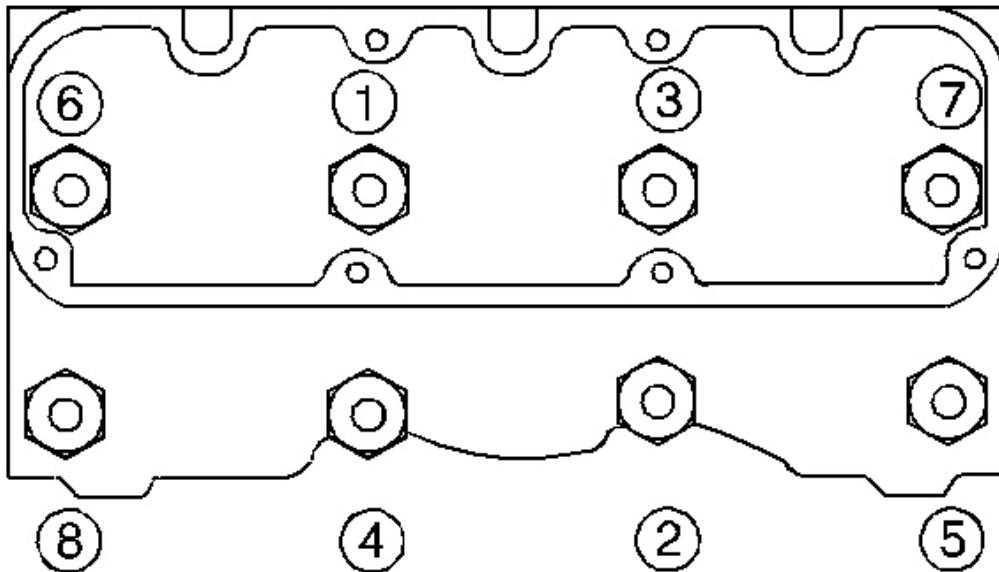
**J 45059** Angle Meter. See Special Tools.

**Installation Procedure**



**Fig. 481: Identifying Cylinder Head & Cylinder Head Bolts**  
Courtesy of GENERAL MOTORS CORP.

1. Install the cylinder head gasket. Ensure the arrows point towards the front of the engine. The left cylinder head gasket has the letter L stamped next to the arrow.
2. Install the cylinder head.



**Fig. 482: Identifying Cylinder Head Bolt Tightening Sequence**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Refer to SPECIAL FASTENER NOTICE .

**NOTE:** Refer to Fastener Notice .

3. Install new cylinder head bolts.

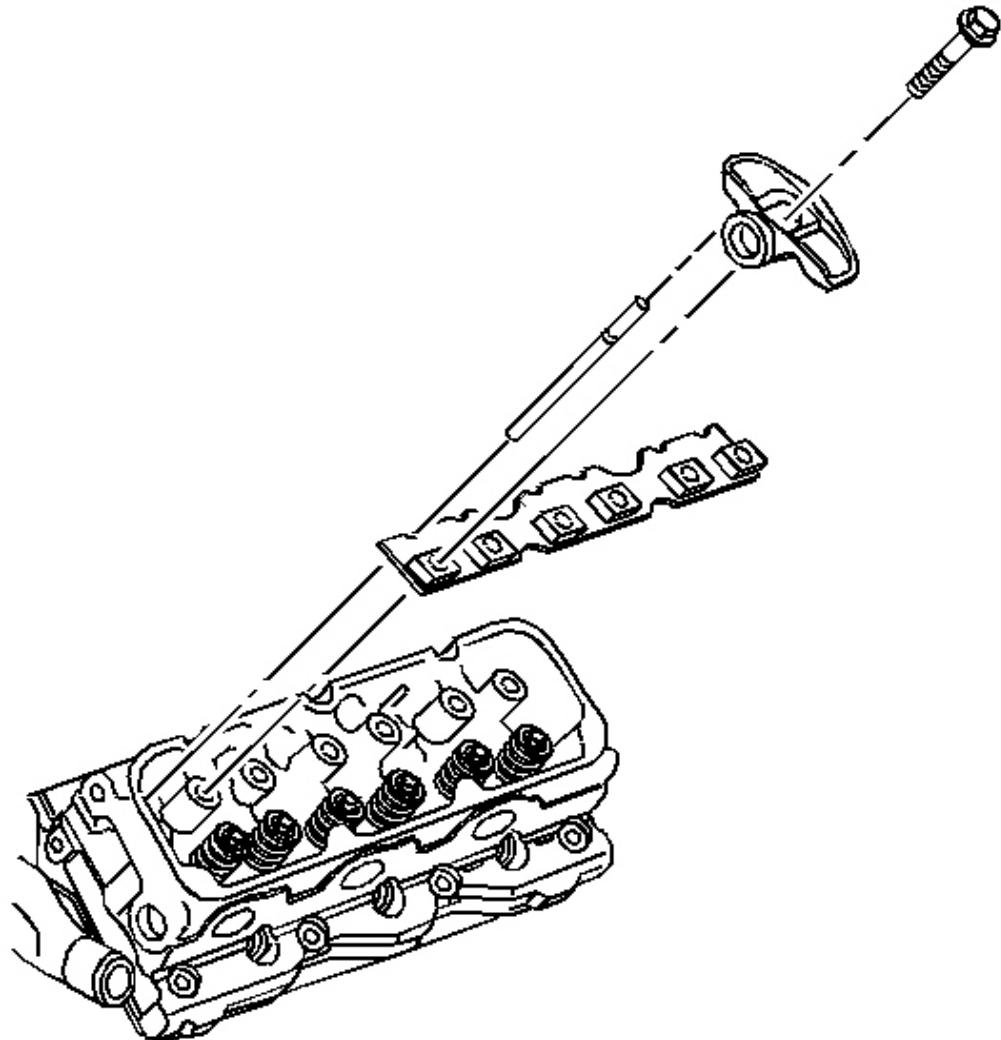
**Tighten:** Tighten the cylinder head bolts to 50 N.m (37 lb ft) in sequence. Using **J 45059** rotate each cylinder head bolt an additional 120 degrees. See Special Tools.

#### **VALVE ROCKER ARM AND PUSH ROD INSTALLATION**

**Tools Required**

**J 45059** Angle Meter. See Special Tools.

**Installation Procedure**



**Fig. 483: View Of Valve Rocker Arm, Bolt, Push Rod & Push Rod Guide Plate**  
Courtesy of GENERAL MOTORS CORP.

1. Install the pushrod guide plate.
2. Install the push rods.
3. Install the valve rocker arm bearing retainer.
4. Coat the valve stem tip and pushrod tip with prelube GM P/N 1052367 (Canadian P/N 992869) or equivalent.

5. Install the valve rocker arms.

**NOTE:** Refer to **SPECIAL FASTENER NOTICE** .

6. Apply threadlocker GM P/N 12345493 (Canadian P/N 10953488) or equivalent to the valve rocker arm bolt threads.

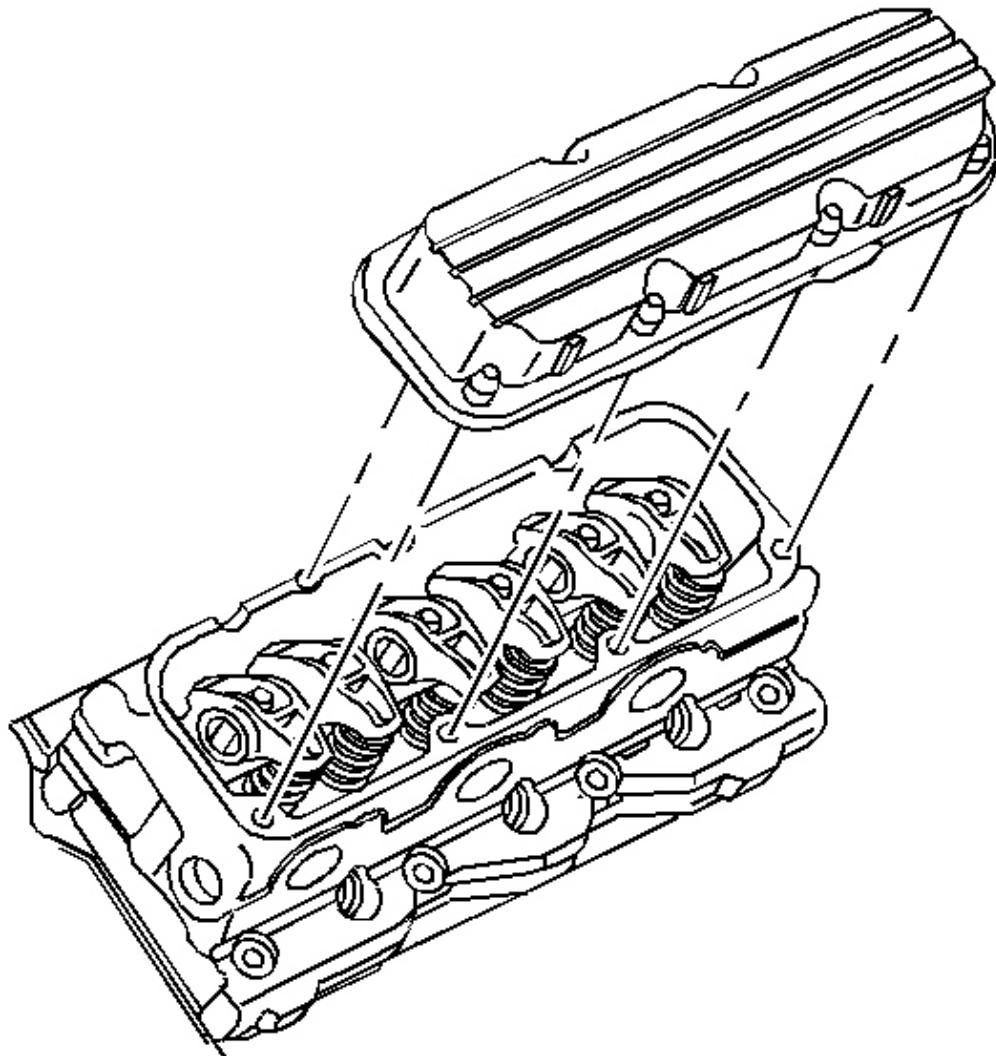
**NOTE:** Refer to **Fastener Notice** .

7. Install the valve rocker arm bolts.

**Tighten:** Tighten the valve rocker arm bolts to 15 N.m (11 lb ft) plus 90 degrees using **J 45059** . See **Special Tools**.

#### **VALVE ROCKER ARM COVER INSTALLATION - RIGHT SIDE**

##### **Installation Procedure**



**Fig. 484: Locating Right Valve Rocker Arm Cover**  
Courtesy of GENERAL MOTORS CORP.

1. Install the valve rocker arm cover.
2. Apply GM P/N 12345382 (Canadian P/N 10953489) threadlocker or the equivalent to the threads.

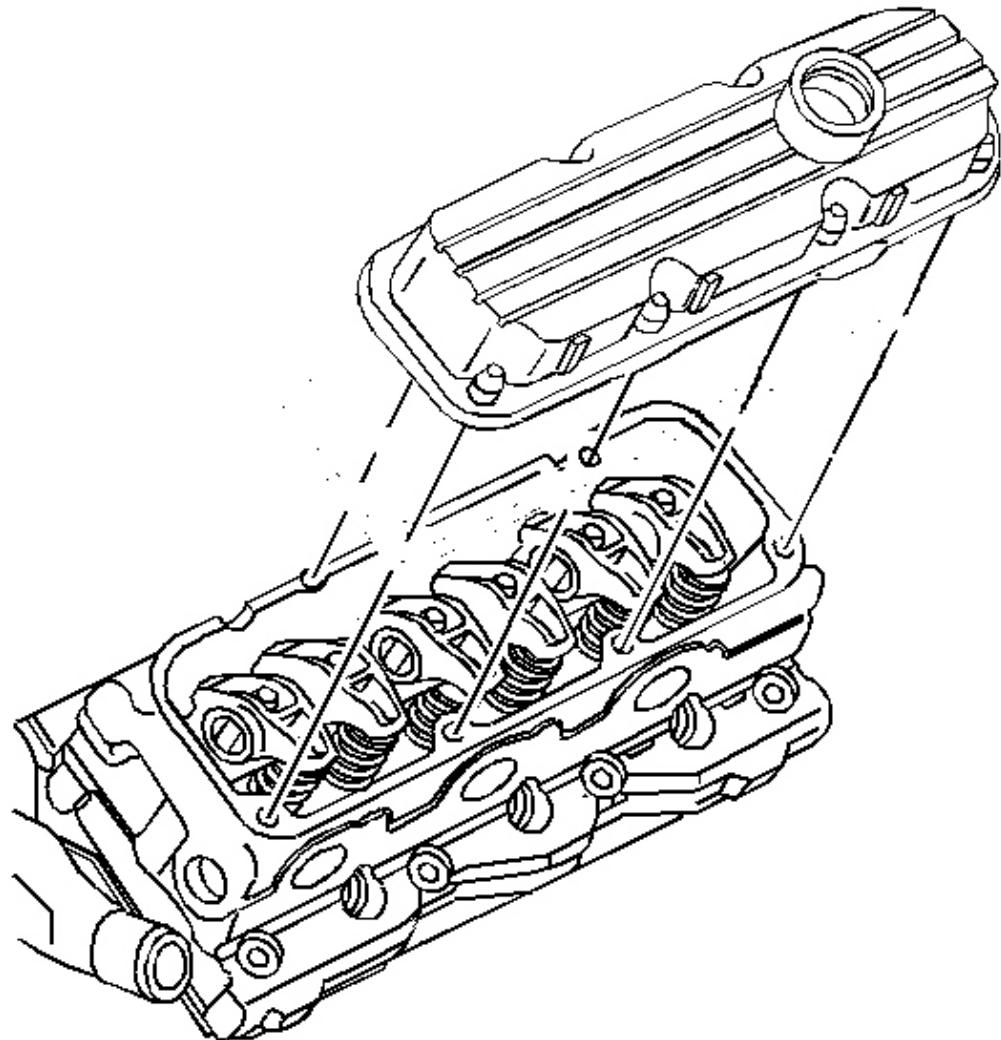
**NOTE: Refer to Fastener Notice .**

3. Install the valve rocker arm cover bolts.

**Tighten:** Tighten the valve rocker arm cover bolts to 10 N.m (89 lb in).

### VALVE ROCKER ARM COVER INSTALLATION - LEFT SIDE

#### Installation Procedure



**Fig. 485: Locating Left Valve Rocker Arm Cover**

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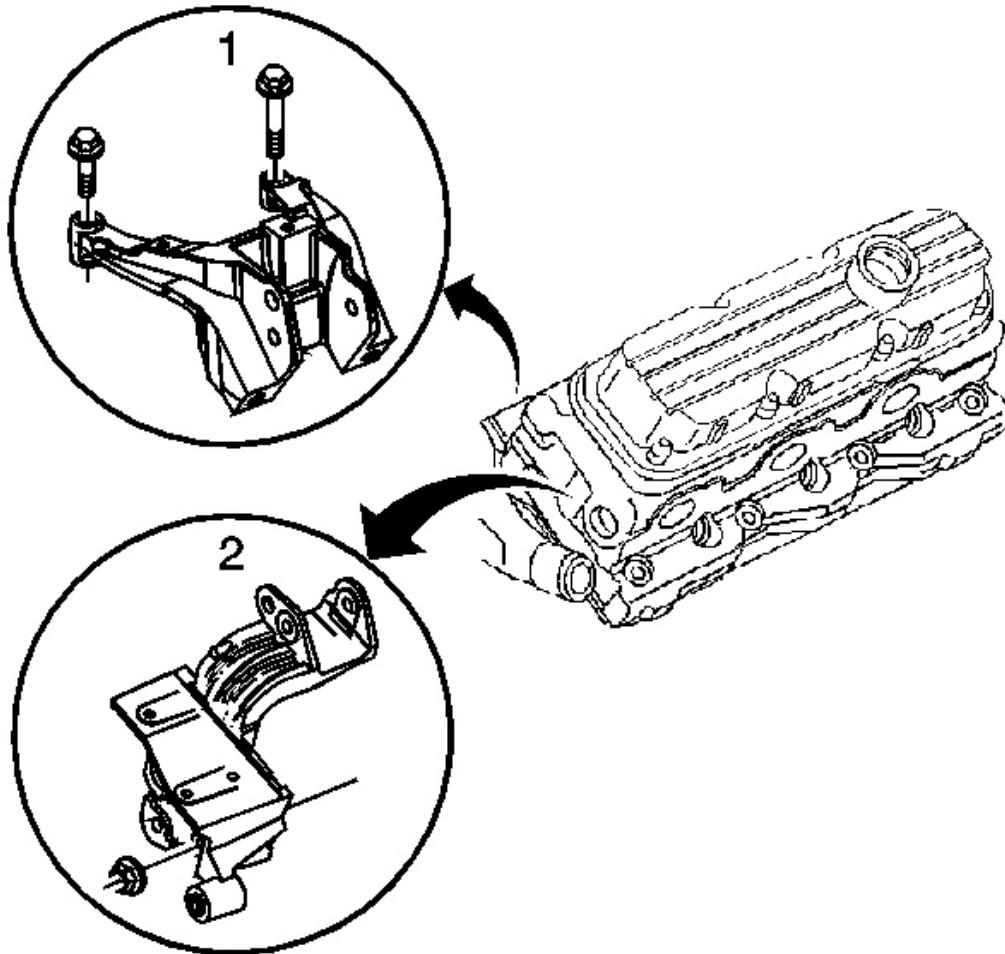
**Courtesy of GENERAL MOTORS CORP.**

1. Install the valve rocker arm cover.
2. Apply GM P/N 12345382 (Canadian P/N 10953489) threadlocker or the equivalent to threads.

**NOTE: Refer to Fastener Notice .**

3. Install the valve rocker arm cover bolts.

**Tighten:** Tighten the valve rocker arm cover bolts to 10 N.m (89 lb in).



**Fig. 486: View of Engine Mount Strut Upper Bracket Bolts**  
Courtesy of GENERAL MOTORS CORP.

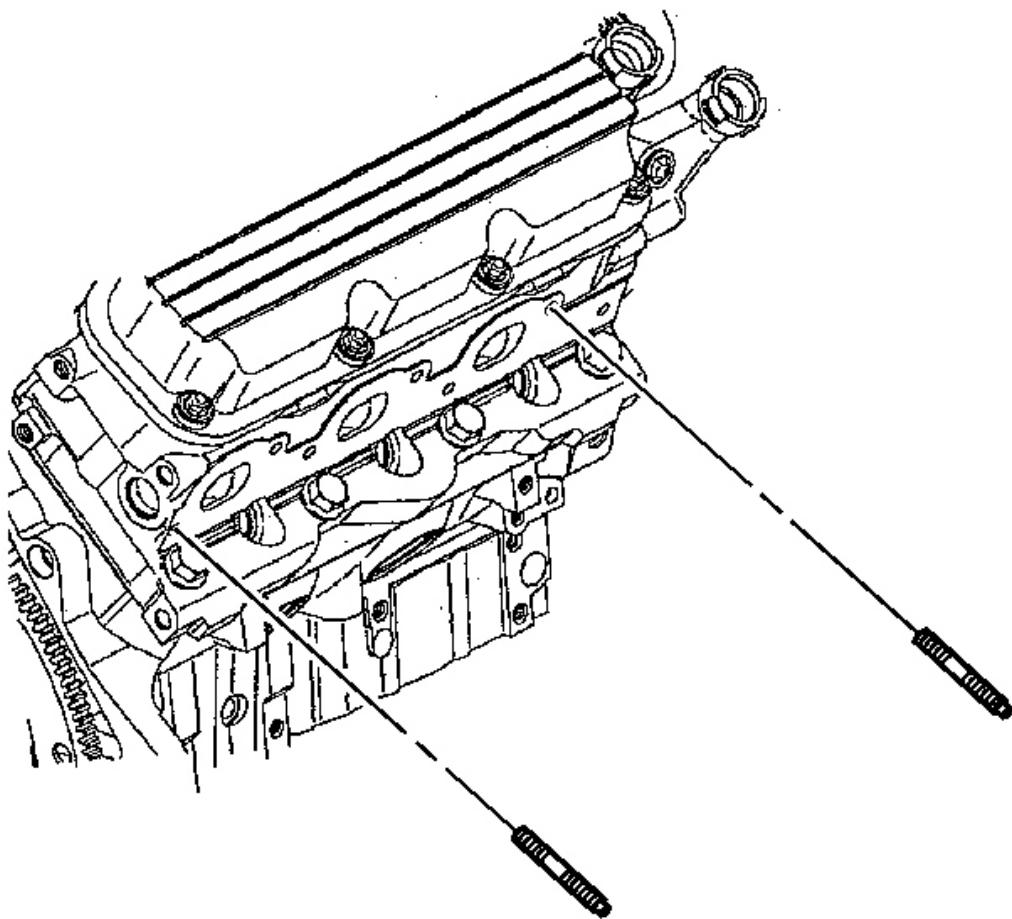
4. Install the engine mount strut upper bracket bolts (1) if applicable.

**Tighten:** Tighten the engine mount strut upper bracket bolts (1) to 50 N.m (37 lb ft).

5. Install the engine mount strut bracket and nuts (2), if applicable.

**Tighten:** Tighten the engine mount strut bracket and nuts (2) to 50 N.m (37 lb ft).

Installation Procedure



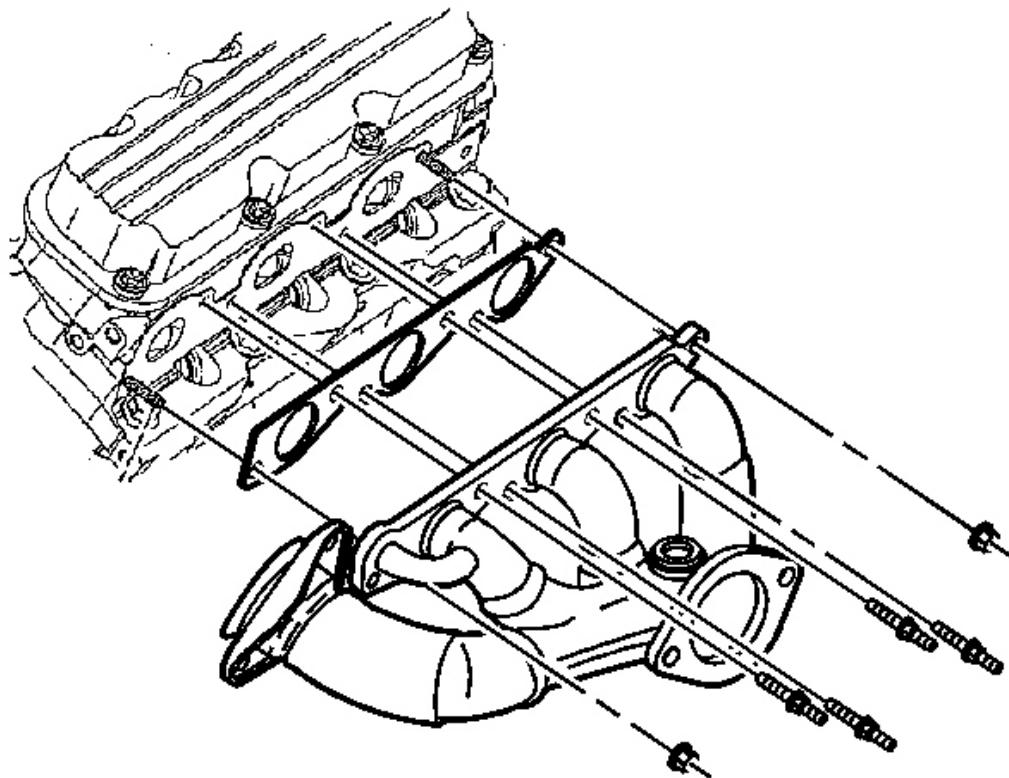
**Fig. 487: Removing/Installing Right Exhaust Manifold**

Courtesy of GENERAL MOTORS CORP.

**NOTE: Refer to Fastener Notice .**

1. Install the exhaust manifold studs.

**Tighten:** Tighten the exhaust manifold studs to 10 N.m (89 lb in).



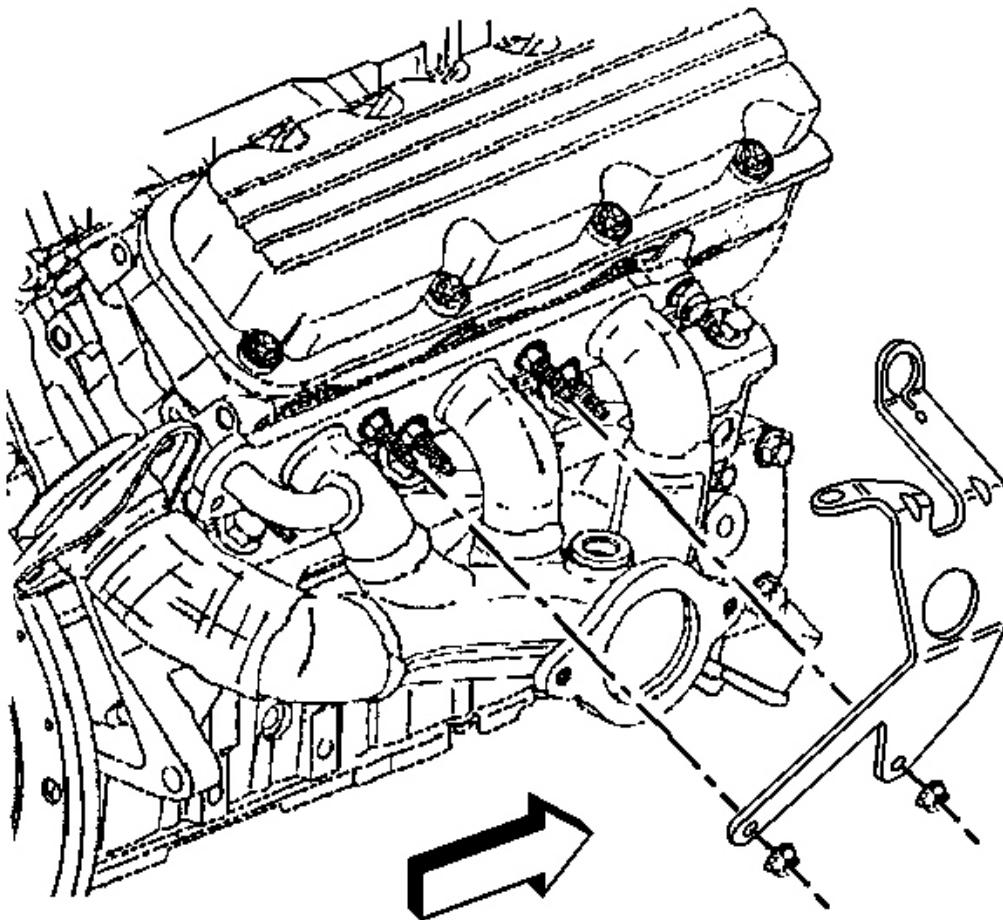
**Fig. 488: Locating Right Exhaust Manifold Components (Without A.I.R.)**  
Courtesy of GENERAL MOTORS CORP.

2. Install the exhaust manifold gasket.
3. Install the exhaust manifold.
4. Install the exhaust manifold bolts and nuts.

**Tighten:** Tighten the exhaust manifold bolts and nuts to 30 N.m (22 lb ft).

5. Install the right side spark plugs.

**Tighten:** Tighten the spark plugs to 15 N.m (11 lb ft).



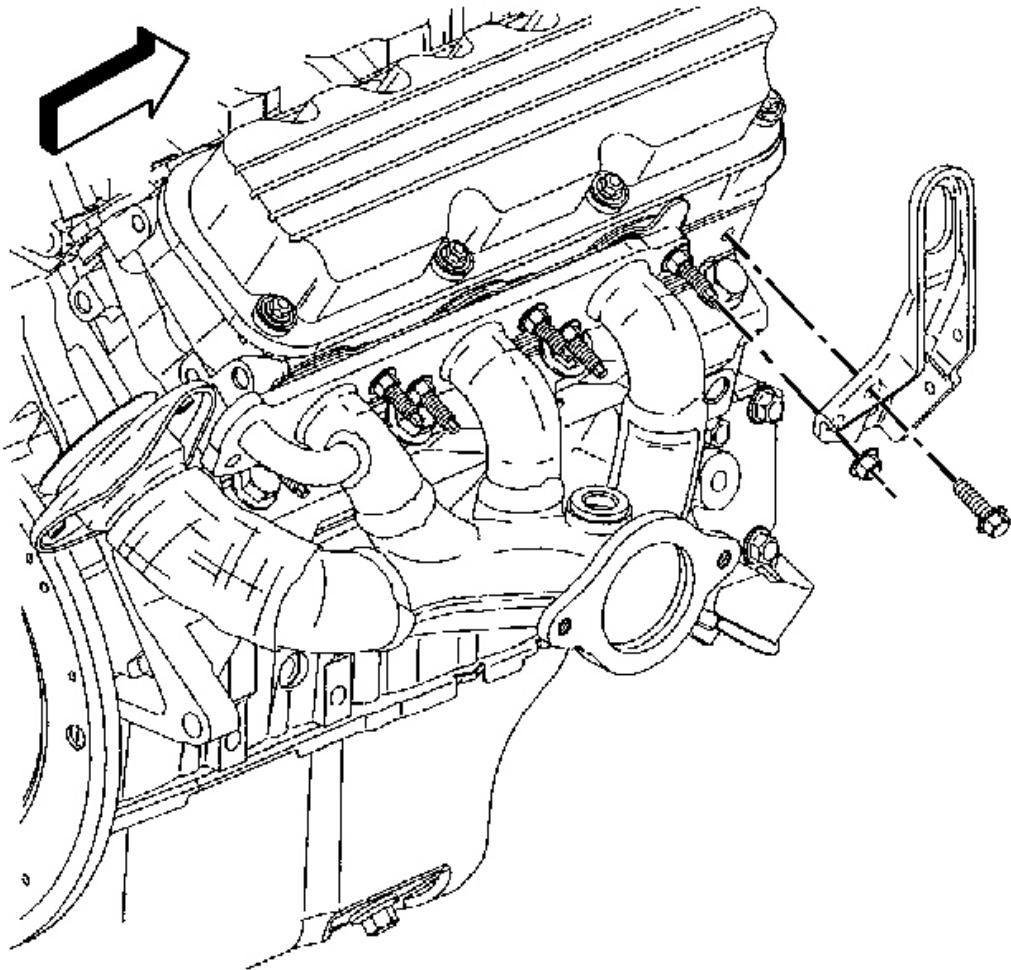
**Fig. 489: Locating Fuel Injector Sight Shield Cover Bracket**  
Courtesy of GENERAL MOTORS CORP.

6. Install the fuel injector sight shield cover bracket.
7. Install the fuel injector sight shield cover bracket nuts.

**Tighten:** Tighten the fuel injector sight shield bracket nuts to 30 N.m (22 lb ft).

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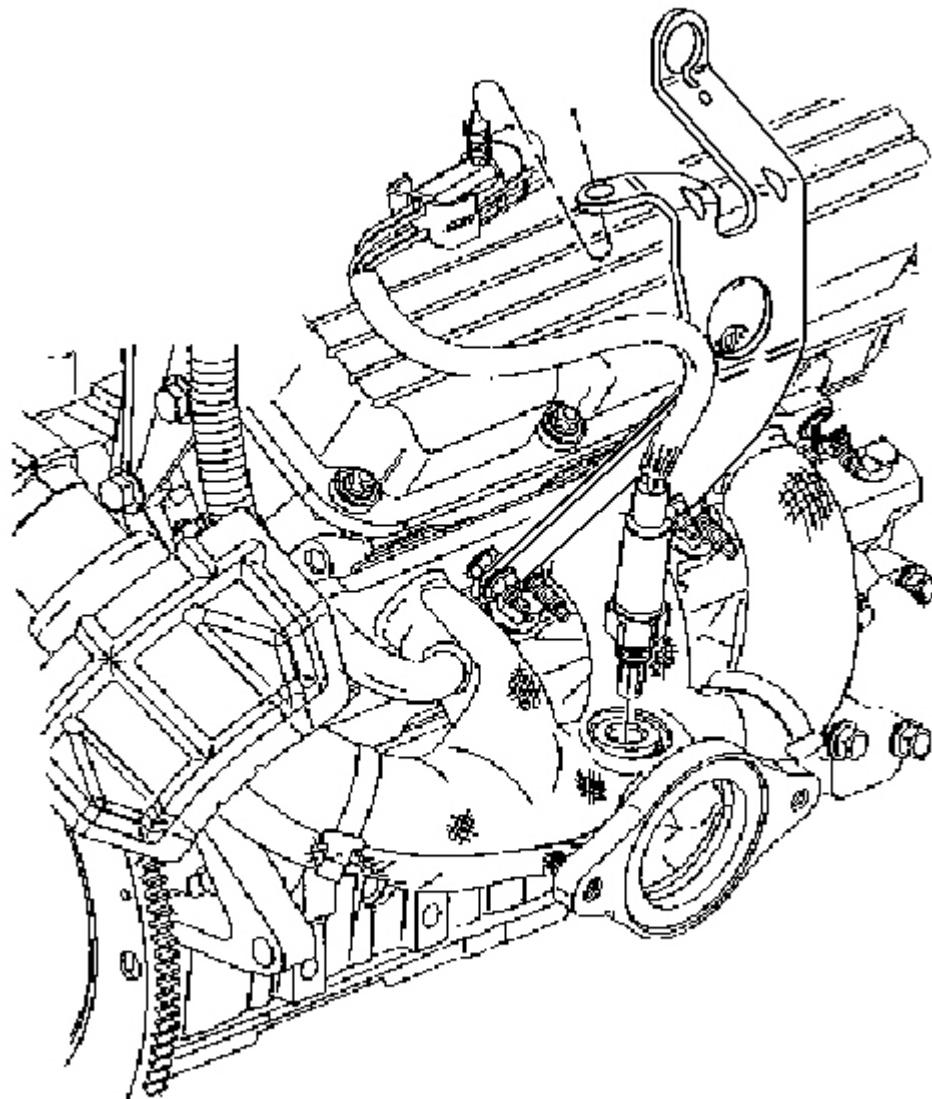
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**Fig. 490: Removing/Installing Right Engine Lift Hook Bracket**  
Courtesy of GENERAL MOTORS CORP.

8. Install the right engine lift hook.
9. Install the right engine lift hook nut and bolt.

**Tighten:** Tighten the right engine lift hook nut and bolt to 30 N.m (22 lb ft).



**Fig. 491: View of Heated Oxygen Sensor**  
Courtesy of GENERAL MOTORS CORP.

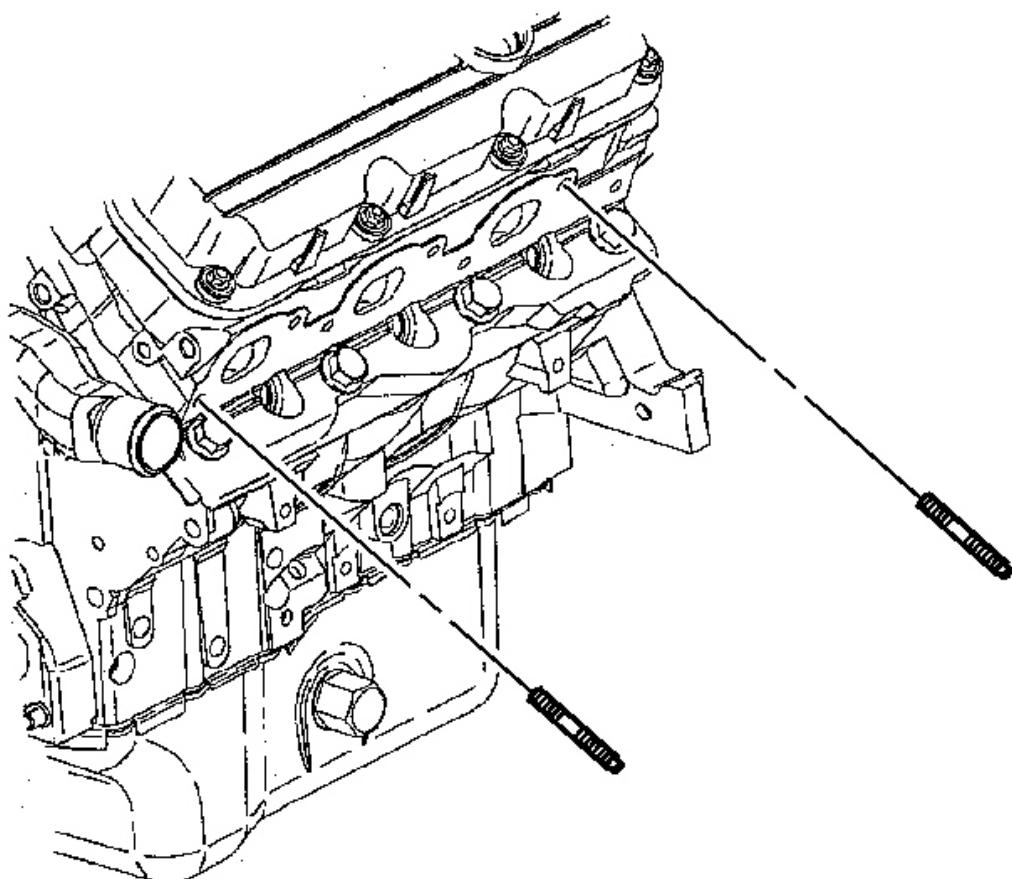
10. Coat the threads of the heated oxygen sensor with anti seize compound.
11. Install the heated oxygen sensor.

**Tighten:** Tighten the heated oxygen sensor to 42 N.m (31 lb ft).

12. Install the heated oxygen sensor lead.

### EXHAUST MANIFOLD INSTALLATION - LEFT SIDE

#### Installation Procedure

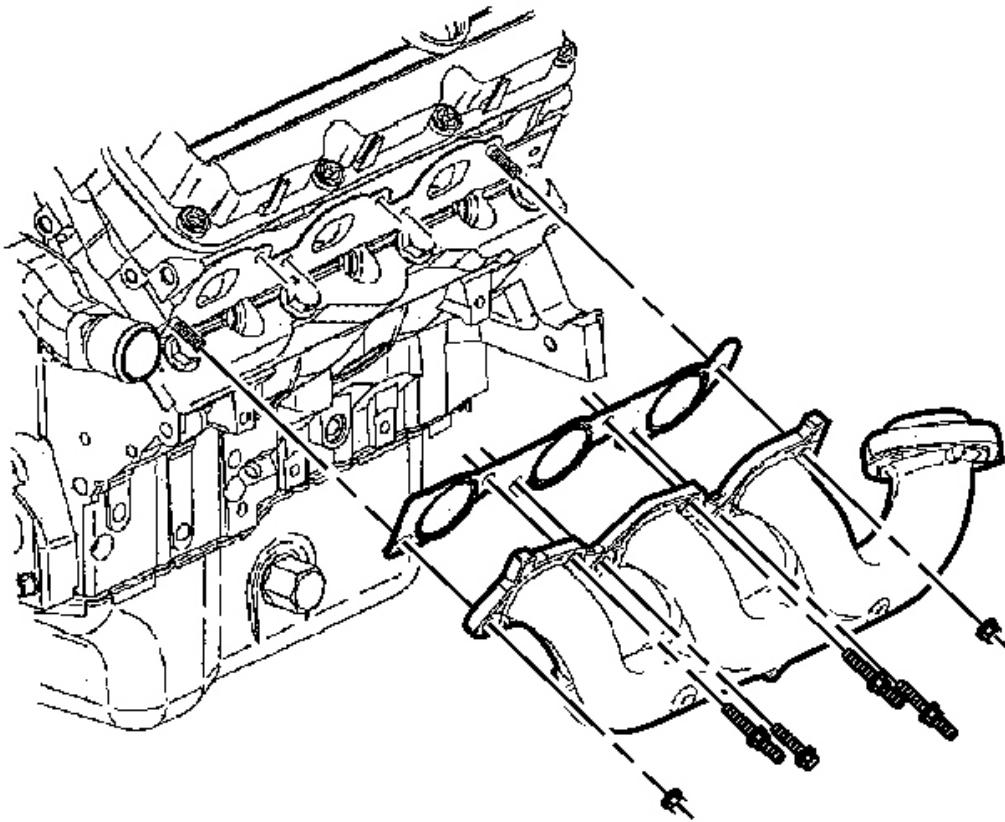


**Fig. 492: Left Exhaust Manifold Studs**  
Courtesy of GENERAL MOTORS CORP.

**NOTE: Refer to Fastener Notice .**

1. Install the exhaust manifold studs.

**Tighten:** Tighten the exhaust manifold studs to 10 N.m (89 lb in).



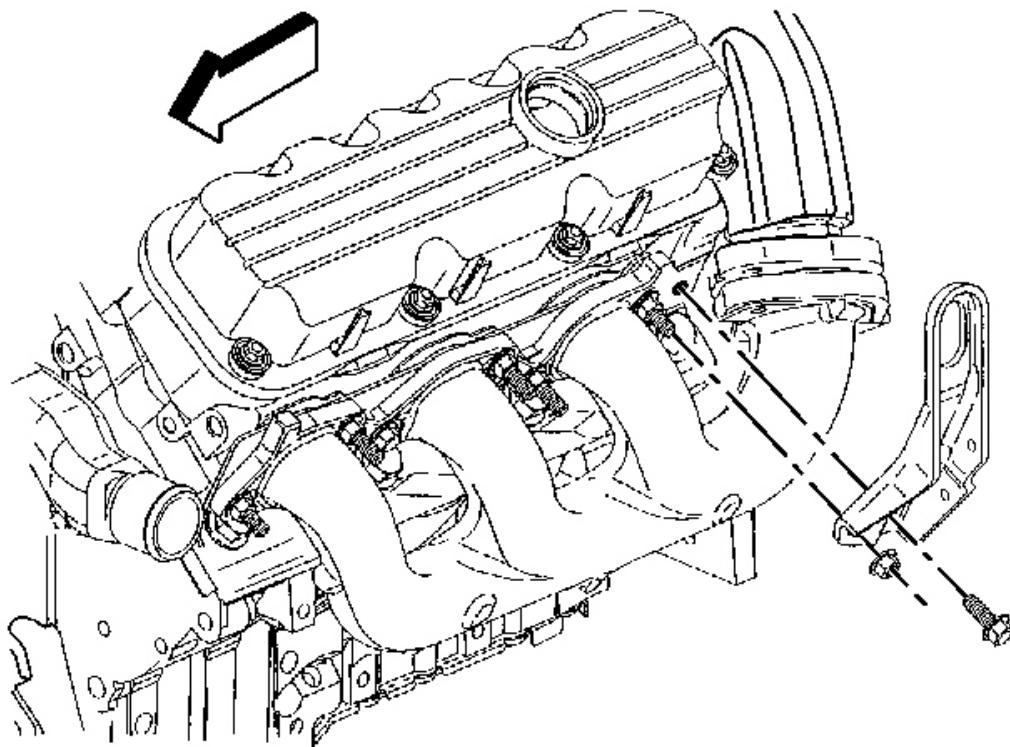
**Fig. 493: Removing/Installing Left Exhaust Manifold**  
Courtesy of GENERAL MOTORS CORP.

2. Install the exhaust manifold gasket.
3. Install the exhaust manifold.
4. Install the exhaust manifold bolts and nuts.

**Tighten:** Tighten the exhaust manifold bolts and nuts to 30 N.m (22 lb ft).

5. Install the left side spark plugs.

**Tighten:** Tighten the spark plugs to 15 N.m (11 lb ft).



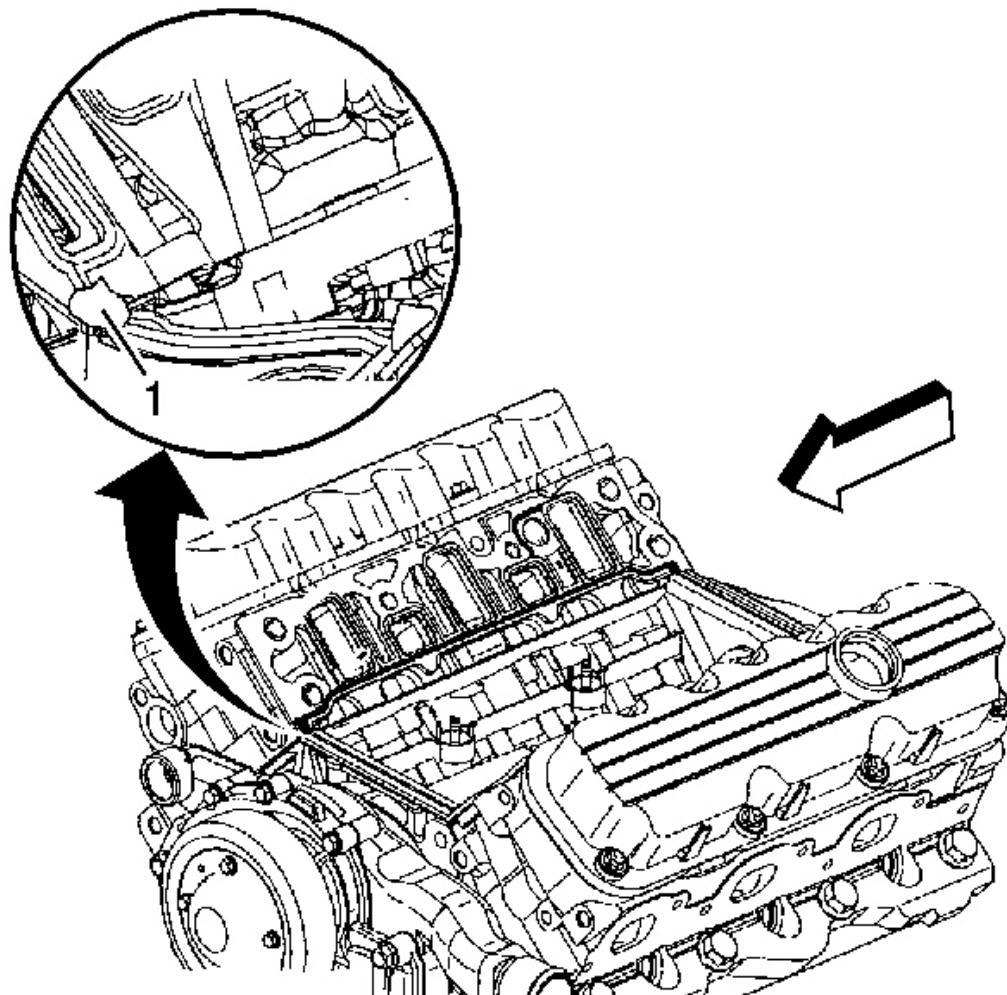
**Fig. 494: Locating Left Engine Lift Hook**  
Courtesy of GENERAL MOTORS CORP.

6. Install the left engine lift hook.
7. Install the left engine lift hook nut and bolt.

**Tighten:** Tighten the left engine lift hook nut and bolt to 30 N.m (22 lb ft).

## LOWER INTAKE MANIFOLD INSTALLATION

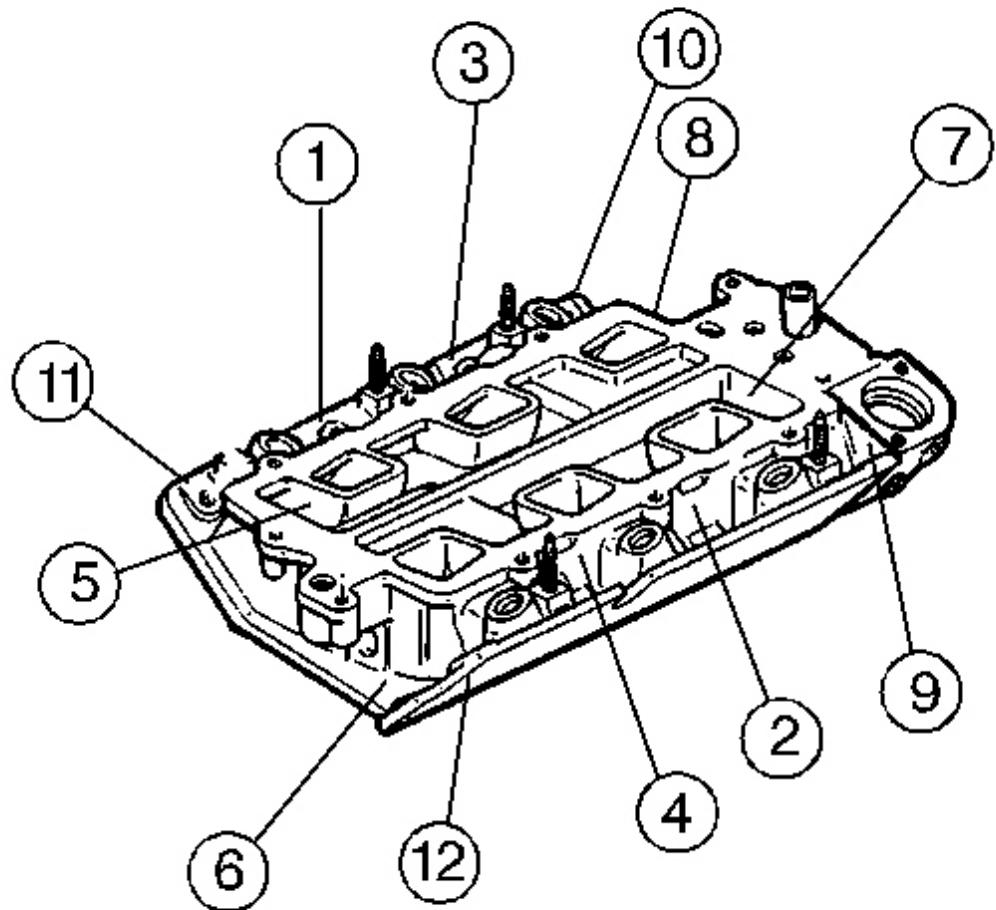
### Installation Procedure



**Fig. 495: Identifying Lower Intake Manifold sealing Points**  
Courtesy of GENERAL MOTORS CORP.

1. Clean the lower intake manifold sealing surface using GM P/N 12346139 (Canadian P/N 10953463) or equivalent prior to installing any seals or gaskets.
2. Install the lower intake manifold gaskets and seals.
3. With gaskets and seals in place, apply a small drop 8-10 mm (0.31-0.39 in) of RTV sealer GM P/N 12378521 (Canadian P/N 88901148) or equivalent, to the 4 corners of the intake manifold to block joints (1).
4. Install the lower intake manifold.

5. Apply threadlocker 272 GM P/N 12345493 (Canadian P/N 10953488) or the equivalent to the bolt threads.



**Fig. 496: Identifying Lower Intake Manifold Bolt Tightening Sequence**  
Courtesy of GENERAL MOTORS CORP.

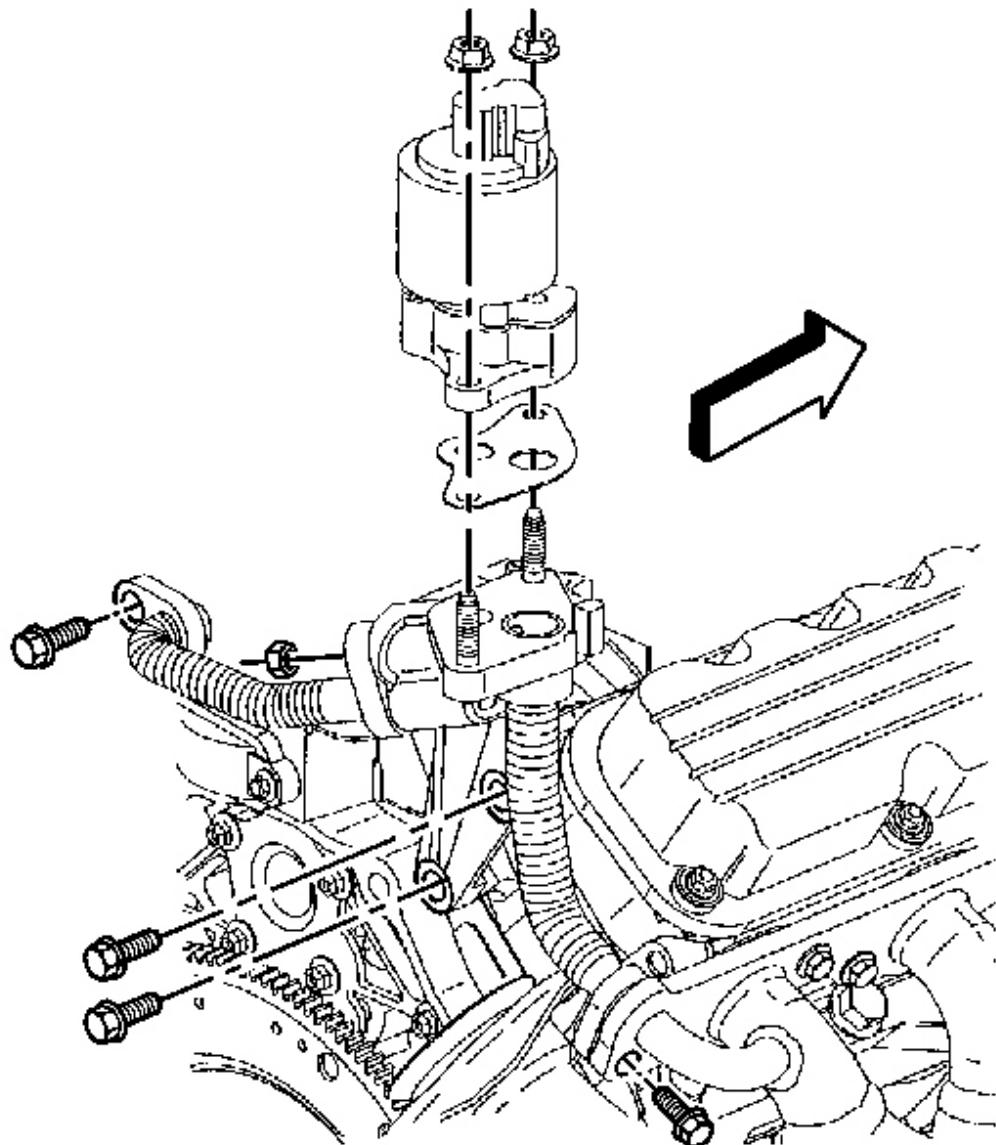
**NOTE: Refer to Fastener Notice .**

6. Install the lower intake manifold bolts.

**Tighten:** Tighten the lower intake manifold bolts in sequence to 15 N.m (11 lb ft).

## EXHAUST GAS RECIRCULATION VALVE AND PIPE INSTALLATION

### Installation Procedure



**Fig. 497: View Of EGR Valve Adapter Assembly**

Courtesy of GENERAL MOTORS CORP.

**IMPORTANT: Inspect the EGR inlet/outlet pipes for leaks before installation. If cracks, deformations or any visible signs of leaking are present, replace the appropriate part.**

1. Install the EGR inlet pipe into the RH exhaust manifold as the EGR valve adapter assembly is installed onto the cylinder head.

**NOTE:** Refer to **Fastener Notice** .

2. Install the EGR valve adapter assembly to cylinder head bolts and the EGR inlet pipe to RH exhaust manifold bolt.

**Tighten:**

- Tighten the EGR valve adapter assembly to cylinder head bolts to 50 N.m (37 lb ft).
- Tighten the EGR inlet pipe to RH exhaust manifold bolt to 29 N.m (21 lb ft).

3. Install the EGR valve outlet pipe to the lower intake and the EGR valve adapter assembly.
4. Install the EGR valve outlet pipe bolt and nut.

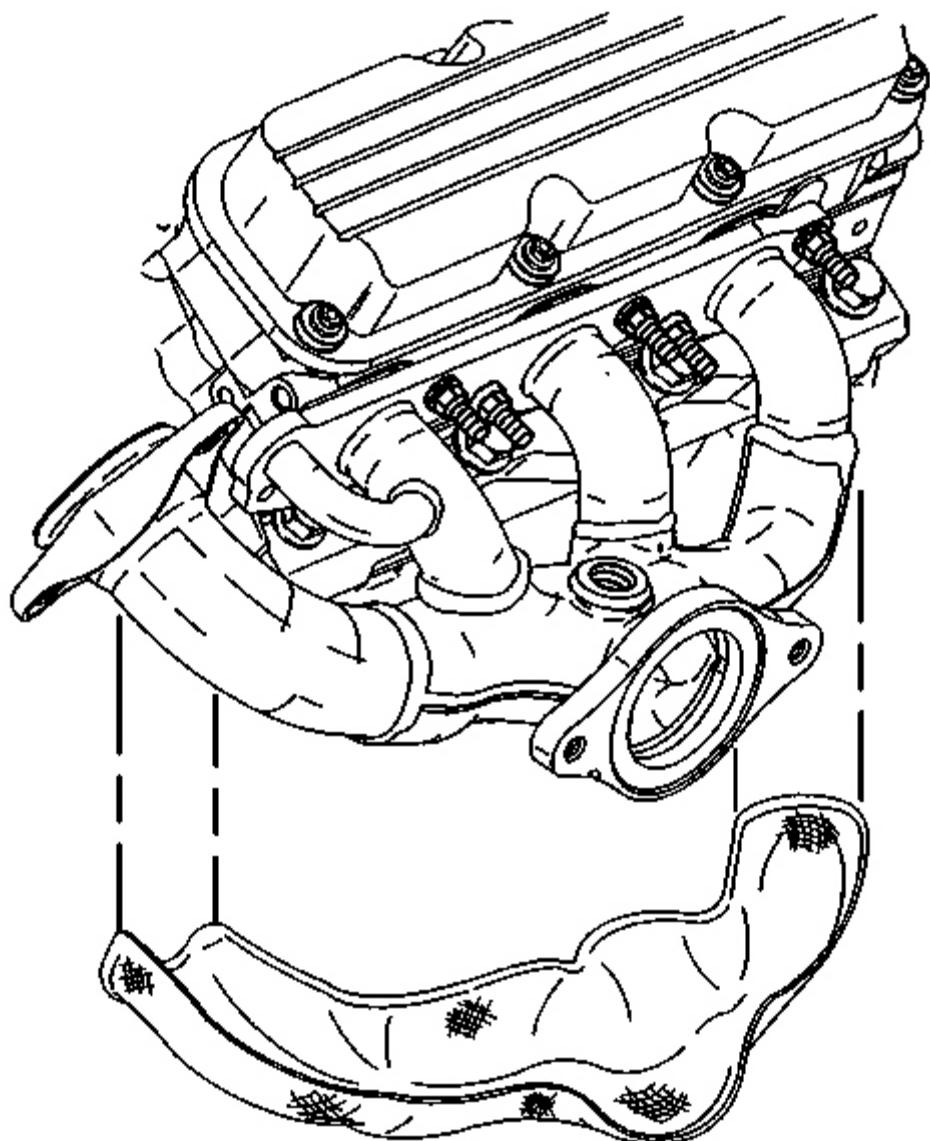
**Tighten:** Tighten the EGR valve outlet pipe bolt and nut to 29 N.m (21 lb ft).

5. Install the EGR valve gasket and EGR valve.
6. Install the EGR valve nuts.

**Tighten:** Tighten the EGR valve nuts to 29 N.m (21 lb ft).

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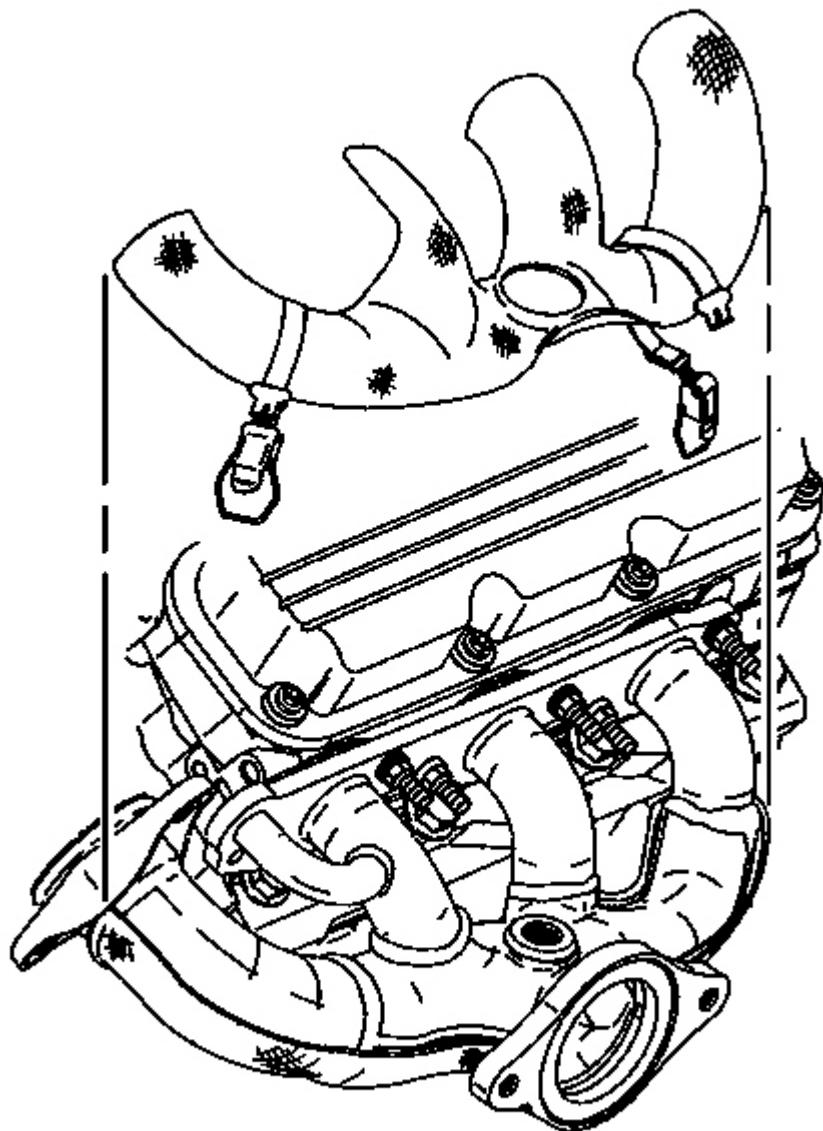
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**Fig. 498: Lower Right Exhaust Manifold Heat Shield (3.8L)**  
Courtesy of GENERAL MOTORS CORP.

7. Install the lower right exhaust manifold heat shield.
8. Install the exhaust manifold heat shield bolts.

**Tighten:** Tighten the exhaust manifold heat shield bolts to 10 N.m (89 lb in).

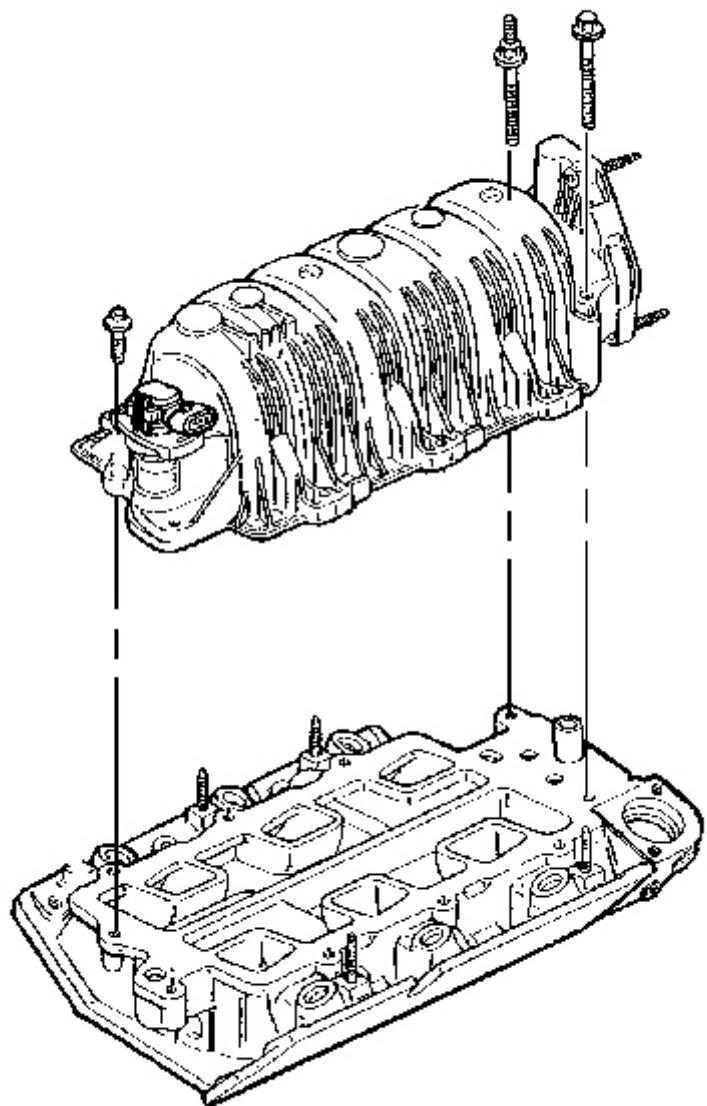


**Fig. 499: Upper Right Exhaust Manifold Heat Shield (3.8L)**  
Courtesy of GENERAL MOTORS CORP.

9. Install the upper right exhaust manifold heat shield.

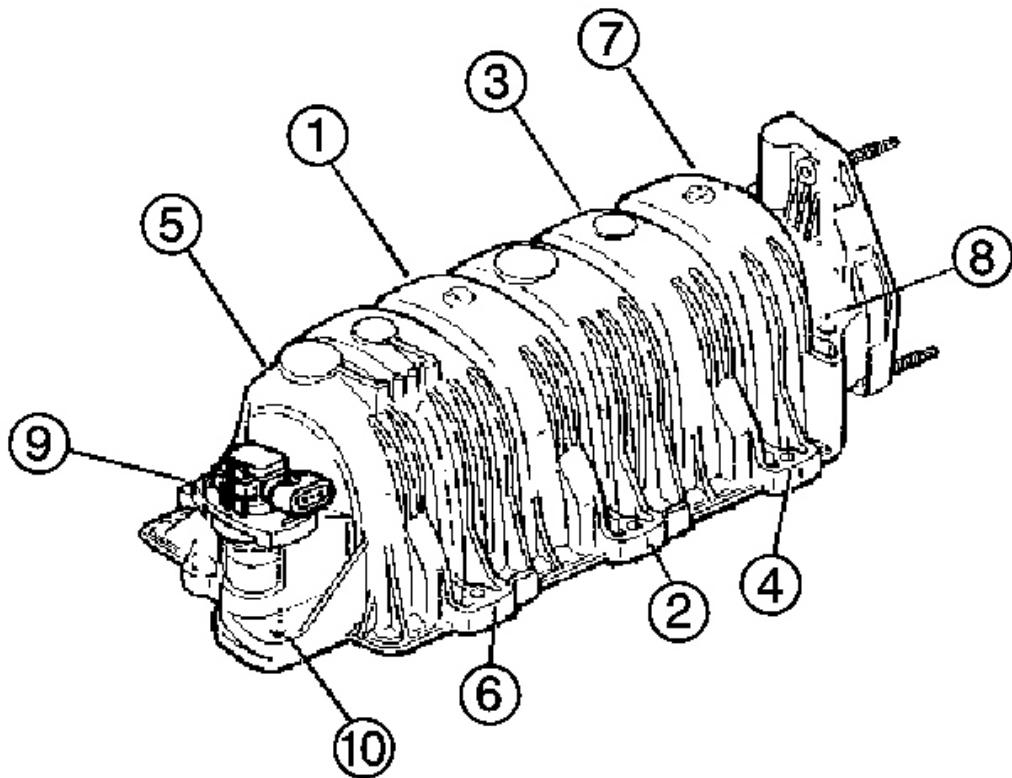
## UPPER INTAKE MANIFOLD INSTALLATION

### Installation Procedure



**Fig. 500: Upper Intake Manifold**  
Courtesy of GENERAL MOTORS CORP.

1. Install the upper intake manifold gasket.
2. Install the upper intake manifold.

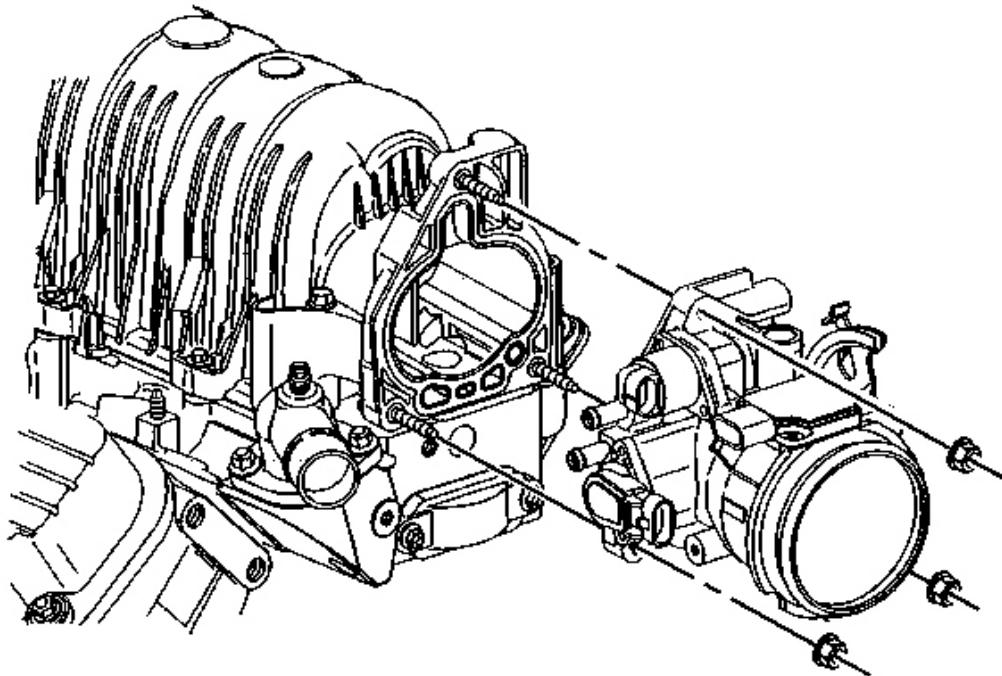


**Fig. 501: Upper Intake Manifold Bolts Tightening Sequence**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Refer to Fastener Notice .

3. Install the upper intake manifold bolts.

**Tighten:** Tighten the upper intake manifold bolts in sequence to 10 N.m (89 lb in).

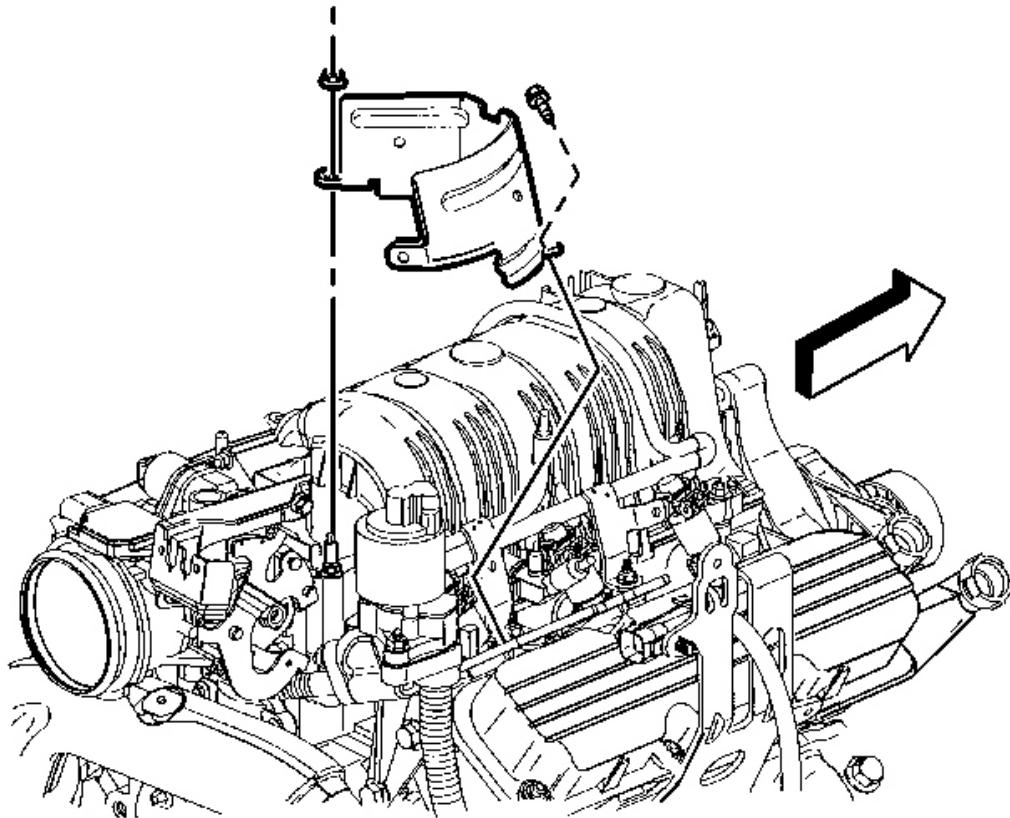


**Fig. 502: Identifying Throttle Body & Gasket**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT: Double check the cleanliness of the throttle body to upper intake surfaces prior to assembly.**

4. Install the throttle body gasket.
5. Install the throttle body.
6. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489) to the threads.
7. Install the throttle body nuts.

**Tighten:** Tighten the throttle body nuts to 10 N.m (89 lb in).

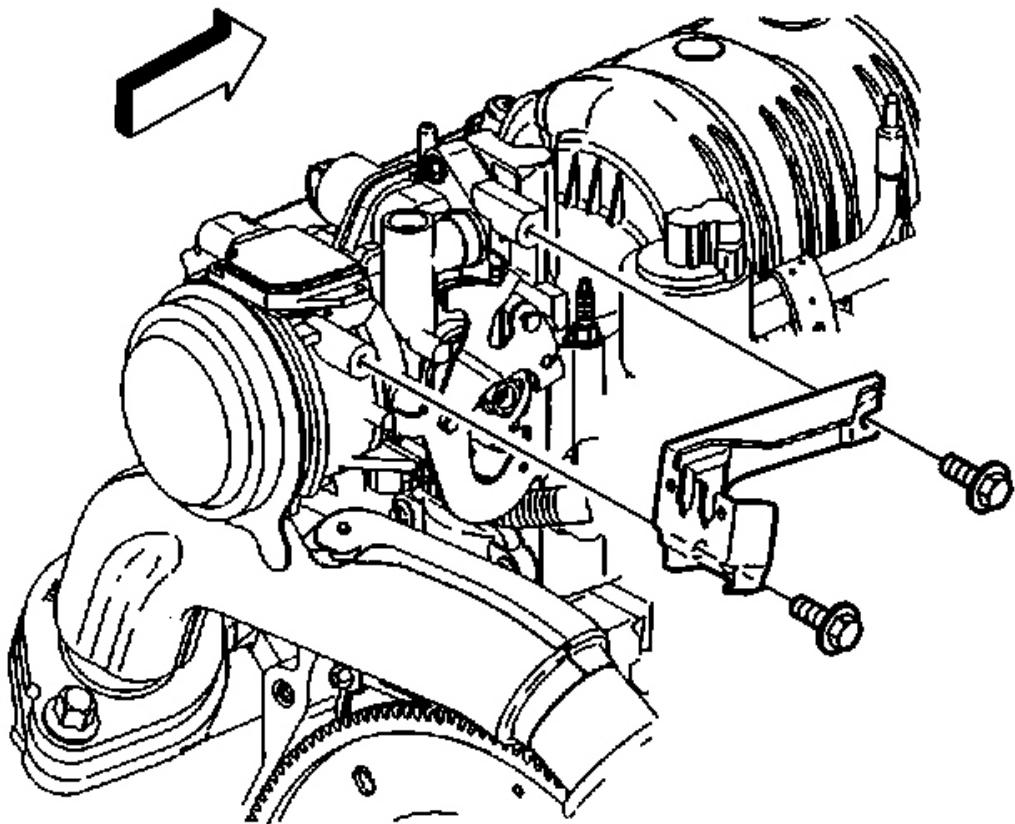


**Fig. 503: Engine Wiring Harness Heat Shield**

Courtesy of GENERAL MOTORS CORP.

8. Install the engine wiring harness heat shield.
9. Install the engine wiring harness heat shield bolt and nut.

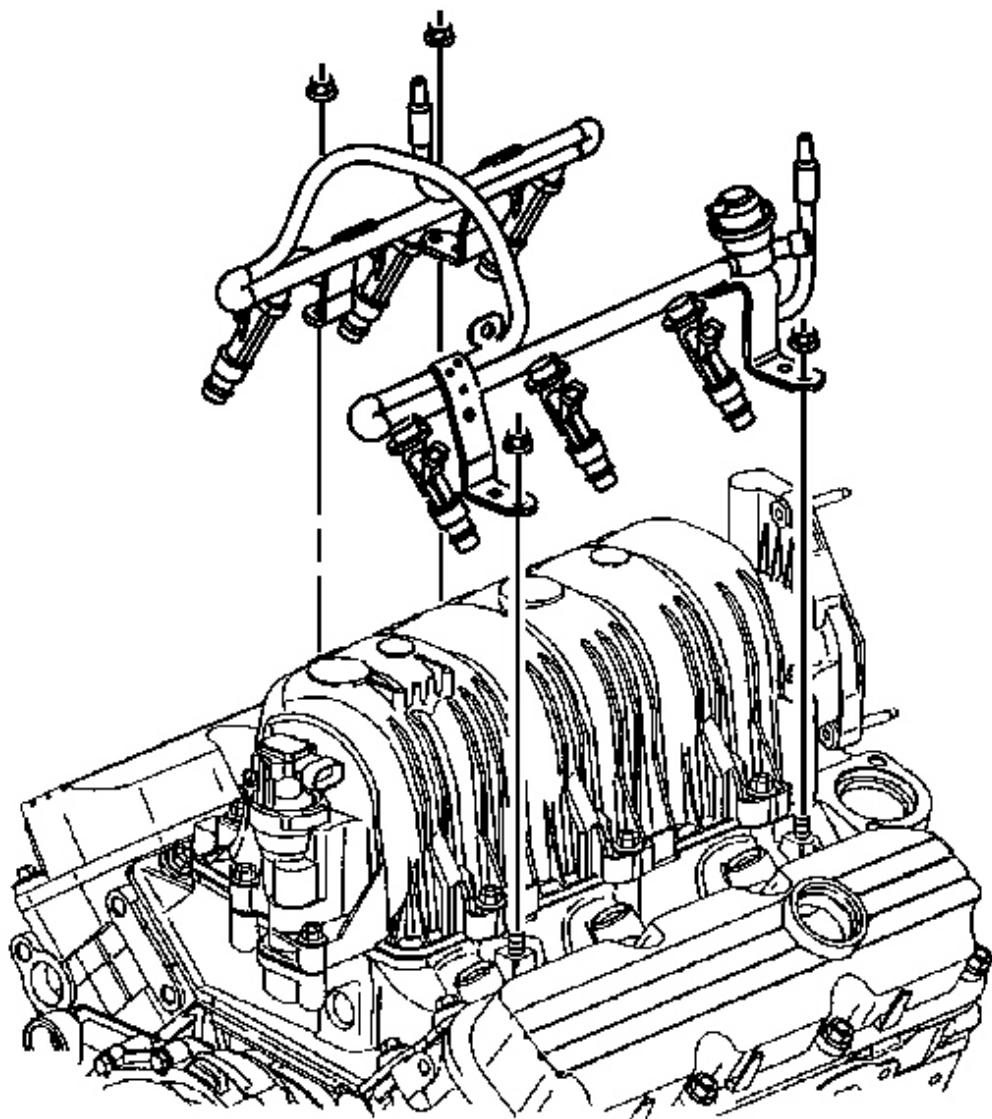
**Tighten:** Tighten the engine wiring harness heat shield bolt and nut to 10 N.m (89 lb in).



**Fig. 504: Accelerator Control Cable Bracket**  
Courtesy of GENERAL MOTORS CORP.

10. Install the accelerator control cable bracket.
11. Install the accelerator control cable bracket bolts.

**Tighten:** Tighten the accelerator control cable bracket bolts to 16 N.m (12 lb ft).



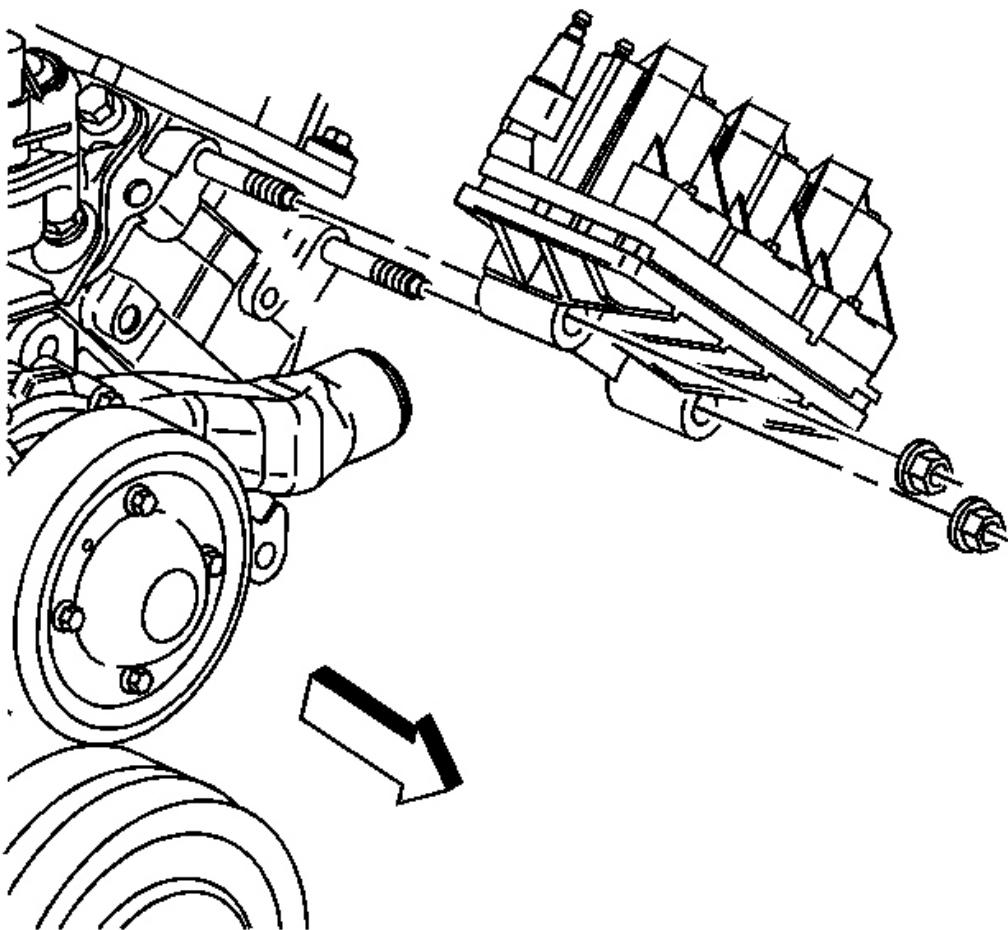
**Fig. 505: Identifying Fuel Injector Rail Bolts**

Courtesy of GENERAL MOTORS CORP.

**IMPORTANT: Do not use the fuel injector O-ring seals twice. Install NEW fuel injector O-ring seals during assembly.**

12. Install the fuel injector rail.
13. Install the fuel injector rail nuts.

**Tighten:** Tighten the fuel injector rail nuts to 10 N.m (89 lb in).



**Fig. 506: Identifying Ignition Control Module Assembly**  
Courtesy of GENERAL MOTORS CORP.

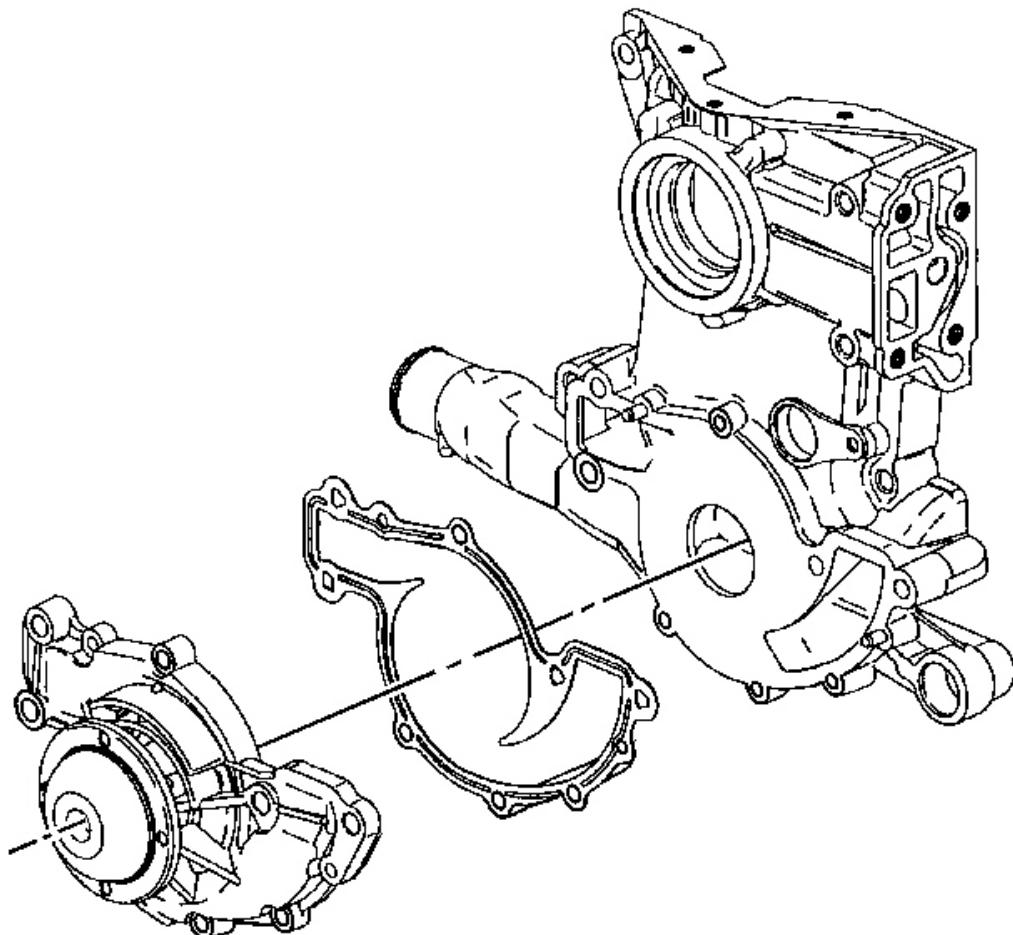
14. Install the ignition control module assembly.
15. Install the ignition control module assembly bracket nuts.

**Tighten:** Tighten the ignition control module assembly bracket nuts to 50 N.m (37 lb ft).

16. Connect the ignition control module connector to the ignition control module assembly.
17. Connect the ignition wires to the fuel injector rail.
18. Install the spark plug wires.

## WATER PUMP INSTALLATION

### Installation Procedure



**Fig. 507: Inspecting Water Pump & Components**  
Courtesy of GENERAL MOTORS CORP.

1. Install the water pump gasket.

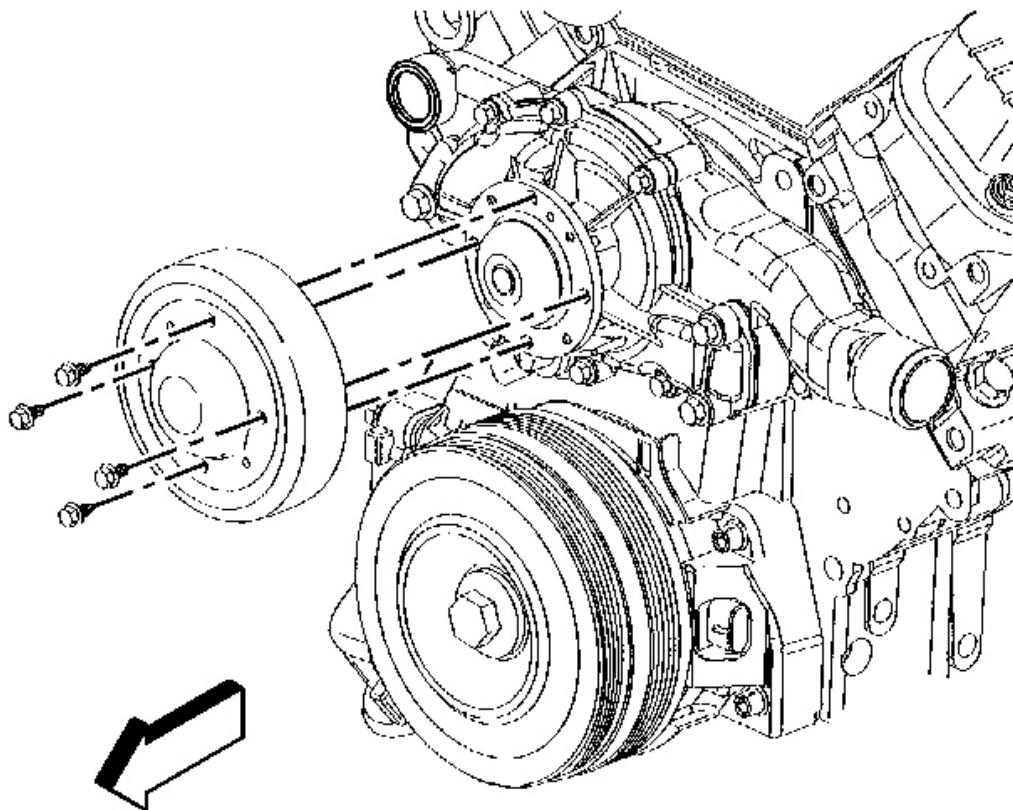
2. Install the water pump.

**NOTE:** Refer to Fastener Notice .

3. Install the water pump bolts.

**Tighten:**

- Tighten the small water pump bolts to 22 N.m (16 lb ft).
- Tighten the large water pump bolts to 34 N.m (25 lb ft).



**Fig. 508: Identifying Water Pump Pulley Bolts**  
Courtesy of GENERAL MOTORS CORP.

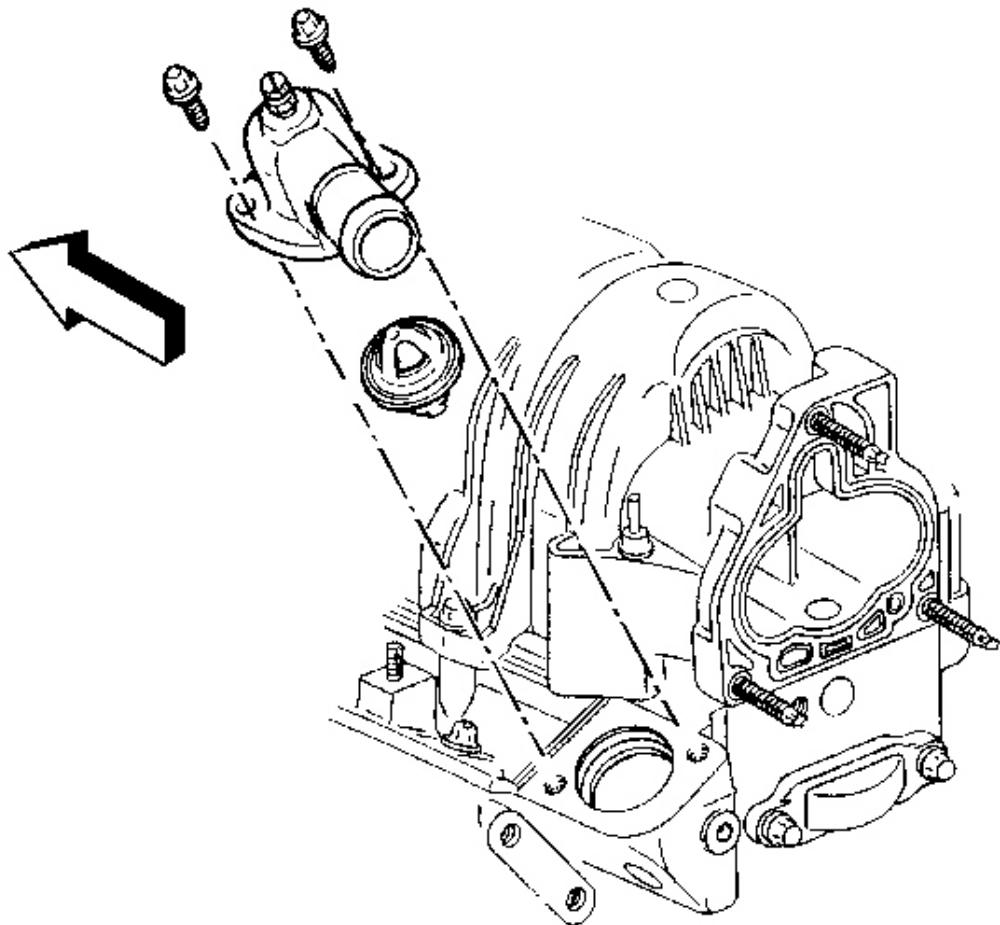
4. Install the water pump pulley.

5. Install the water pump pulley bolts.

**Tighten:** Tighten the water pump pulley bolts to 13 N.m (116 lb in).

## WATER OUTLET AND THERMOSTAT INSTALLATION

### Installation Procedure



**Fig. 509: Identifying Water Outlet & Thermostat**  
Courtesy of GENERAL MOTORS CORP.

1. Install the thermostat.

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2. Install the water outlet.

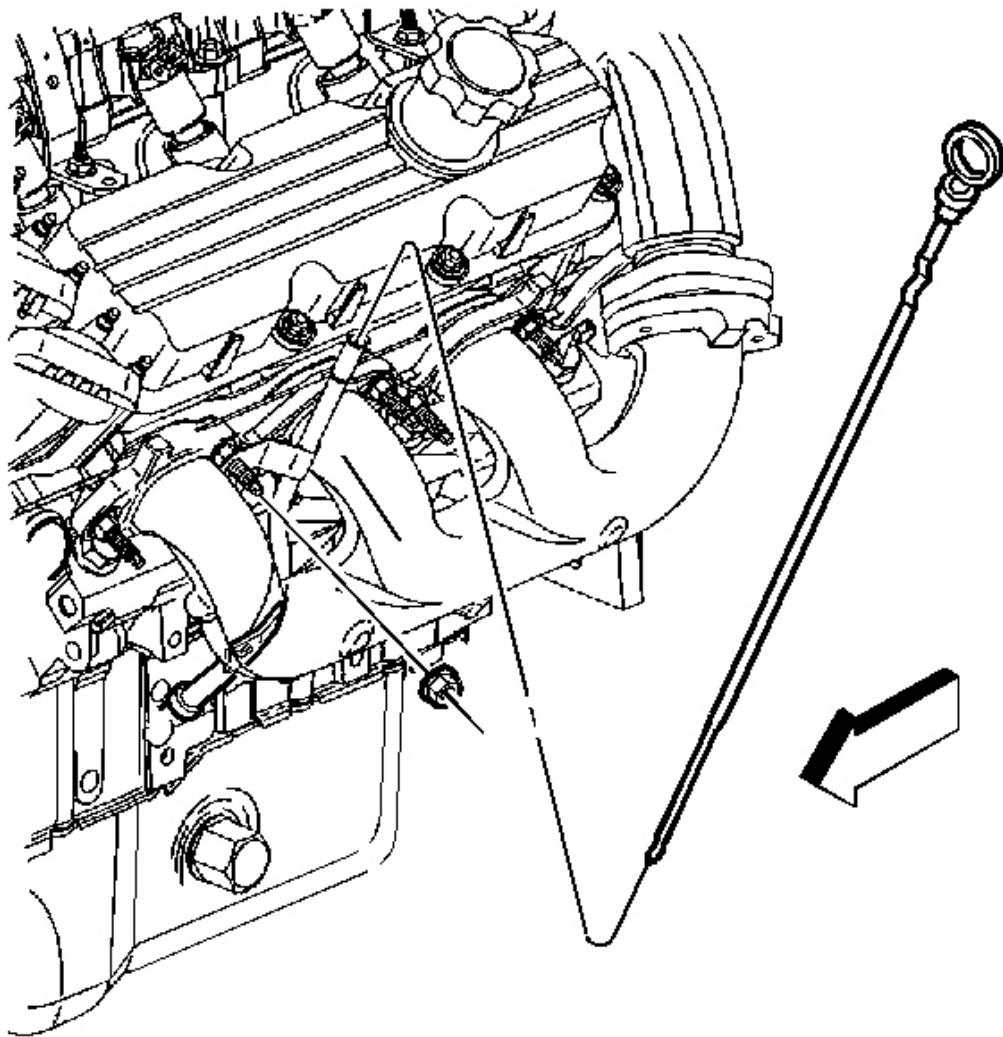
**NOTE:** Refer to Fastener Notice .

3. Install the water outlet bolts.

**Tighten:** Tighten the water outlet bolts to 27 N.m (20 lb ft).

## OIL LEVEL INDICATOR AND TUBE INSTALLATION

### Installation Procedure



**Fig. 510: Locating Oil Level Indicator & Tube**  
Courtesy of GENERAL MOTORS CORP.

1. Install the oil level indicator tube.
  - Lubricate the O-ring with engine oil and make sure it is in place.
  - Ensure that the assembly is fully seated in the engine block.

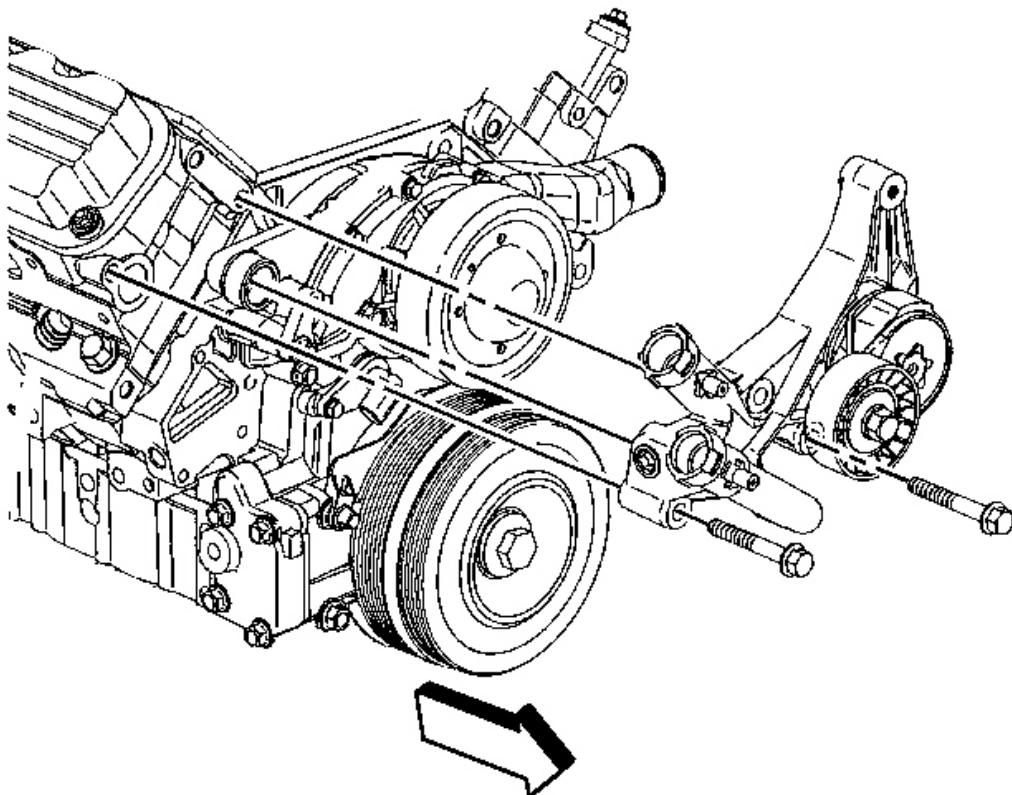
**NOTE: Refer to Fastener Notice .**

2. Install the oil level indicator tube nut.

**Tighten:** Tighten the nut to 20 N.m (15 lb ft).

## DRIVE BELT TENSIONER INSTALLATION

### Installation Procedure



**Fig. 511: Drive Belt Tensioner Bracket & Bolts**  
Courtesy of GENERAL MOTORS CORP.

1. Install the drive belt tensioner bracket.

**NOTE: Refer to Fastener Notice .**

2. Install the drive belt tensioner bracket bolts.

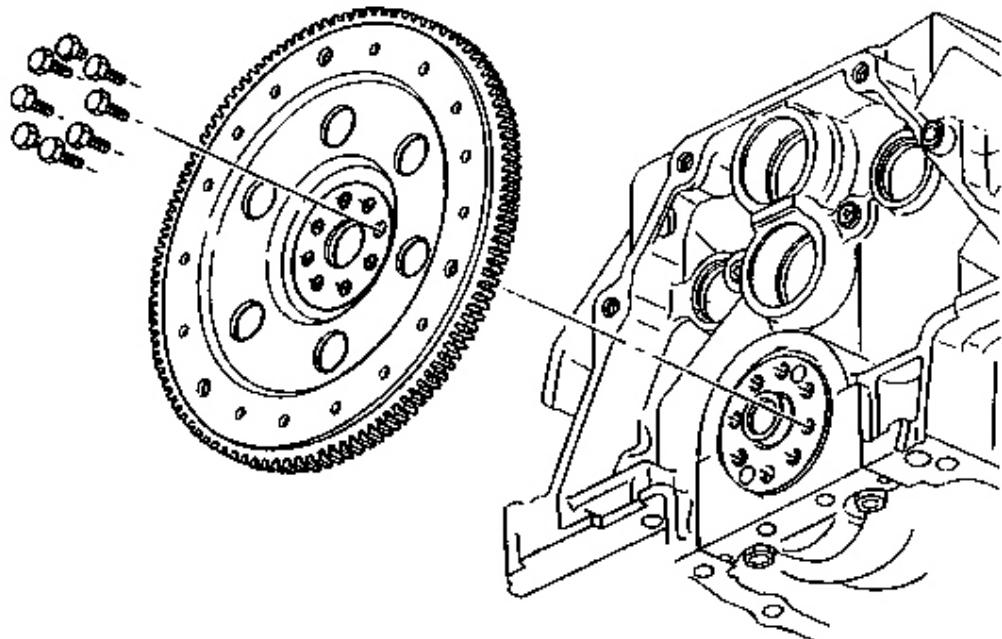
**Tighten:** Tighten the drive belt tensioner bolts to 50 N.m (37 lb ft).

## ENGINE FLYWHEEL INSTALLATION

### Tools Required

- **J 37096** Flywheel Holder. See [Special Tools](#).
- **J 45059** Angle Meter. See [Special Tools](#).

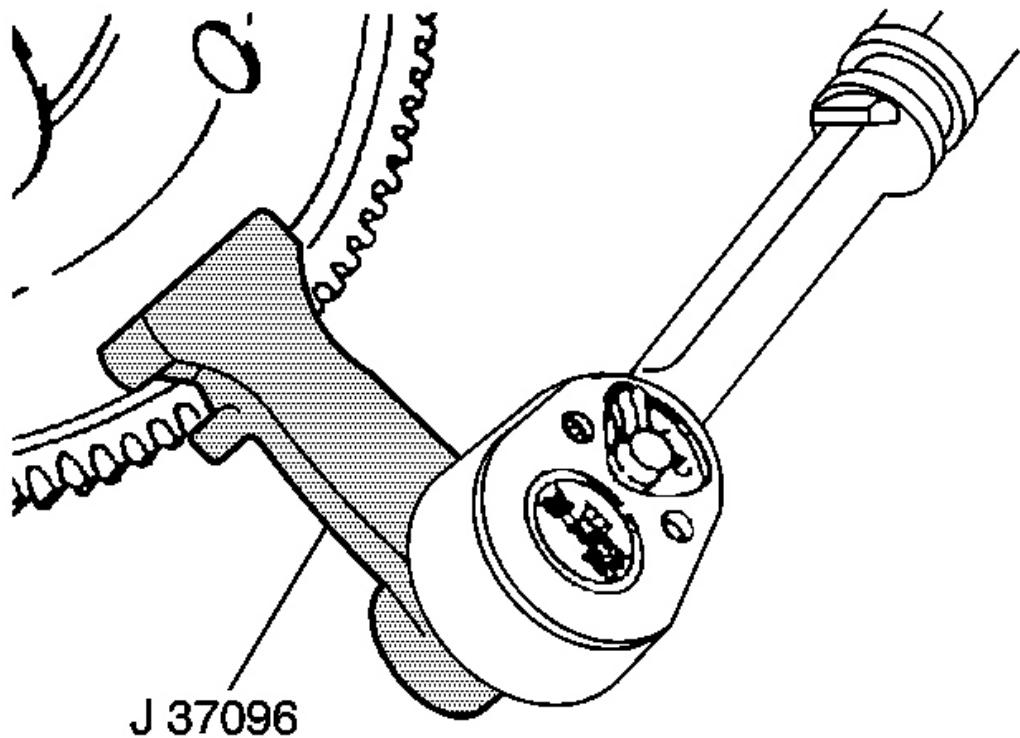
### Installation Procedure



**Fig. 512: Engine Flywheel & Bolts**

Courtesy of GENERAL MOTORS CORP.

1. Install the flywheel.



**Fig. 513: Holding Flywheel**

Courtesy of GENERAL MOTORS CORP.

2. Use the **J 37096** to secure the flywheel in order to prevent the crankshaft from rotating. See Special Tools.

**NOTE:** Refer to Fastener Notice .

3. Install the new flywheel bolts.

**Tighten:** Tighten the bolts to 15 N.m (11 lb ft). Use the **J 45059** to tighten the bolts an additional 50 degrees. See Special Tools.

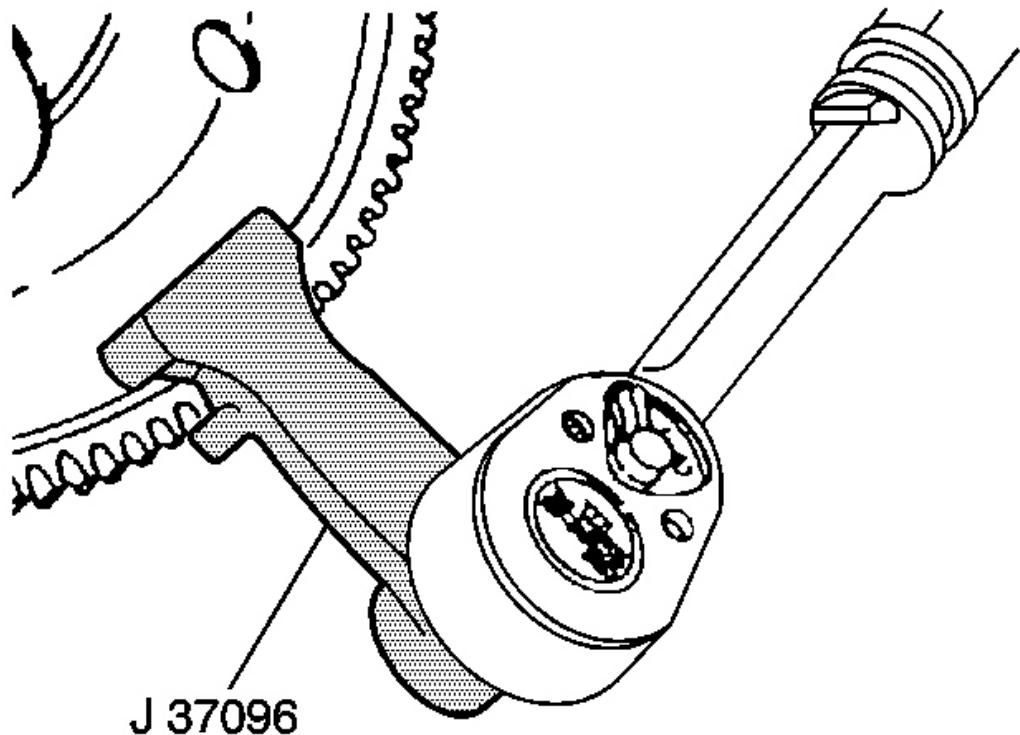
#### CRANKSHAFT BALANCER INSTALLATION

Tools Required

- **J 37096** Flywheel Holder. See Special Tools.

- **J 45059** Angle Meter. See Special Tools.

#### Installation Procedure



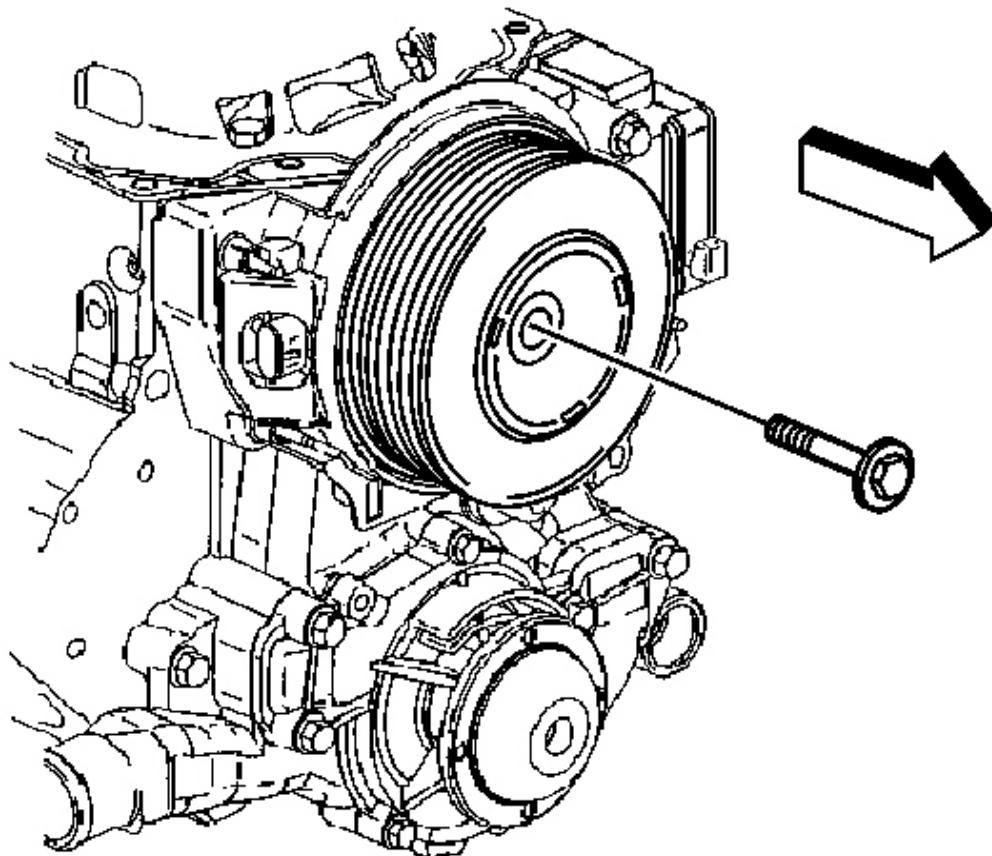
**Fig. 514: Holding Flywheel**

Courtesy of GENERAL MOTORS CORP.

1. Lubricate the seal surface of the crankshaft balancer with engine oil.

**IMPORTANT: The crankshaft position sensor system variation learn procedure must be completed whenever the crankshaft is replaced.**

2. Install the crankshaft balancer.
3. Use **J 37096** to hold the flywheel. See Special Tools.



**Fig. 515: View Of Crankshaft Balancer Bolt**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Refer to Special Fastener Notice .

**NOTE:** Refer to Fastener Notice .

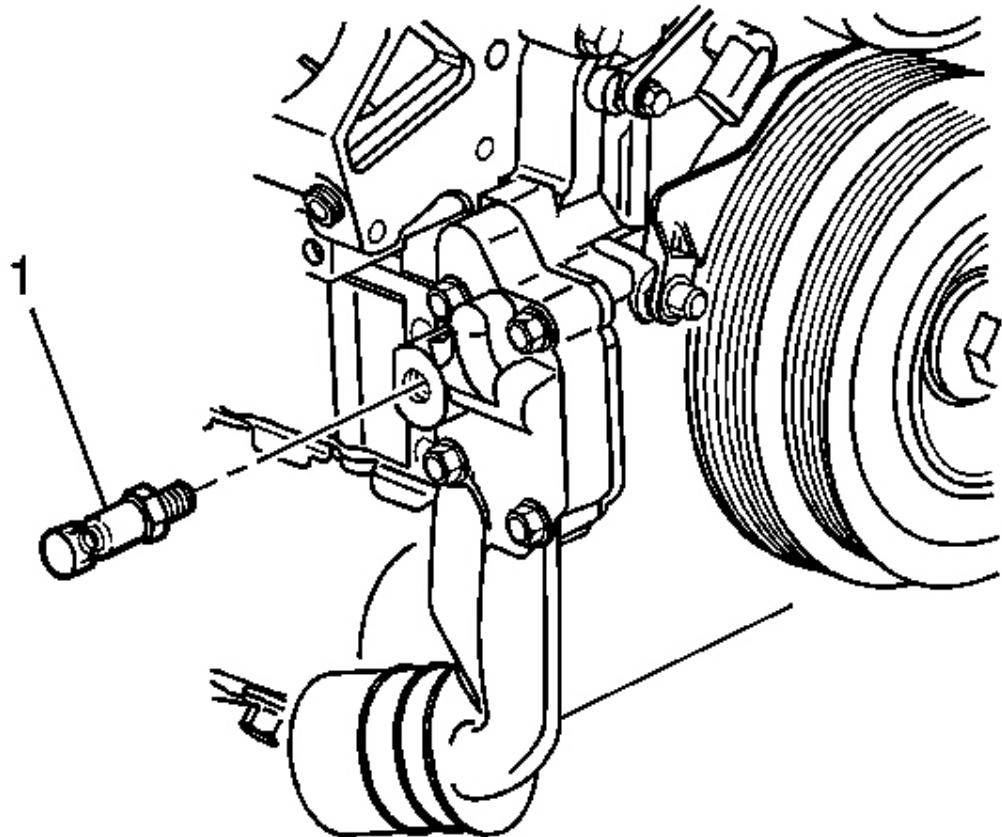
4. Install the crankshaft balancer bolt.

**Tighten:** Tighten the crankshaft balancer bolt to 150 N.m (111 lb ft). Use **J 45059** to tighten the crankshaft balancer bolt an additional 76 degrees. See Special Tools.

Tools Required

**J 45299** Engine Preluber. See Special Tools.

Prelubing Procedure



**Fig. 516: Locating Engine Oil Pressure Sensor/Switch**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** A constant/continuous flow of clean engine oil is required in order to properly prime the engine. Be sure to use an approved engine oil as specified in the owners manual.

1. Remove the engine oil filter and fill with clean engine oil.

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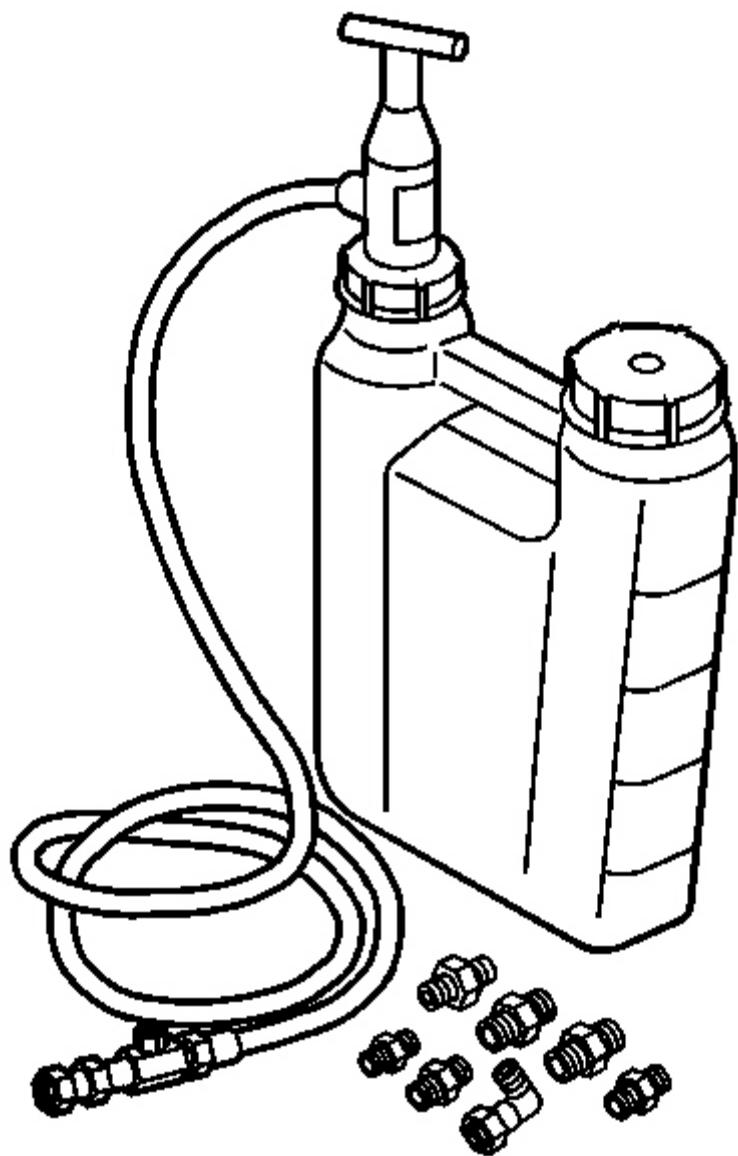
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**NOTE:** Refer to Fastener Notice .

2. Install the oil filter.

**Tighten:** Tighten the oil filter to 30 N.m (22 lb ft).

3. Locate the oil pressure sensor (1) on left side of engine and remove.
4. Install the 1/4 inch adapter P/N 509373.



**Fig. 517: Identifying Engine Preluber J 45299**  
Courtesy of GENERAL MOTORS CORP.

5. Install the flexible hose to the adapter and open the valve.
6. Pump the handle on **J 45299** to flow a minimum of 1-2 quarts (1-1. See **Special Tools**.9

liters) of engine oil. Observe the flow of engine oil through the flexible hose and into the engine assembly.

7. Close the valve and remove the flexible hose and adapter from the engine.
8. Install the oil pressure sensor.

**Tighten:** Tighten the oil pressure sensor to 16 N.m (12 lb ft).

9. Top off the engine oil to the proper level.

## **DESCRIPTION AND OPERATION**

### **CRANKCASE VENTILATION SYSTEM DESCRIPTION**

A crankcase ventilation system is used to consume crankcase vapors created during the combustion process instead of venting them to the atmosphere.

Fresh air is supplied through a filter to the crankcase, the crankcase mixes the fresh air with the blow-by gases and then passed through a positive crankcase ventilation (PCV) orificed tube into the intake manifold.

The PCV orificed tube restricts the flow rate of the blow-by gases using a 3 mm (0.118 in) (a) orifice located at the end of the tube. If abnormal operating conditions arise, the system is designed to allow excessive amounts of blow-by gases to back flow through the crankcase vent tube into the throttle body in order to be consumed by normal combustion.

### **DRIVE BELT SYSTEM DESCRIPTION**

The drive belt system consists of the following components:

- The drive belt
- The drive belt tensioner
- The drive belt idler pulley
- The crankshaft balancer pulley
- The accessory drive component mounting brackets
- The accessory drive components
  - The power steering pump, if belt driven
  - The generator
  - The A/C compressor, if equipped
  - The engine cooling fan, if belt driven

- The water pump, if belt driven
- The vacuum pump, if equipped
- The air compressor, if equipped

The drive belt system may use 1 belt or 2 belts. The drive belt is thin so that it can bend backwards and has several ribs to match the grooves in the pulleys. The drive belts are made of different types of rubbers, chloroprene or EPDM and have different layers or plies containing either fiber cloth or cords for reinforcement.

Both sides of the drive belt may be used to drive the different accessory drive components. When the back side of the drive belt is used to drive a pulley, the pulley is smooth.

The drive belt is pulled by the crankshaft balancer pulley across the accessory drive component pulleys. The spring loaded drive belt tensioner keeps constant tension on the drive belt to prevent the drive belt from slipping. The drive belt tensioner arm will move when loads are applied to the drive belt by the accessory drive components and the crankshaft.

The drive belt system may have an idler pulley, which is used to add wrap to the adjacent pulleys. Some systems use an idler pulley in place of an accessory drive component when the vehicle is not equipped with the accessory.

## **ENGINE COMPONENT DESCRIPTION**

### **Engine Construction**

Starting at the front of the engine, the cylinders of the left bank are numbered 1-3-5 and the cylinders of the right bank are numbered 2-4-6. The crankshaft is supported in the engine block by four bearings. The crankshaft is counterbalanced by the flywheel, the crankshaft balancer and the weights cast into the crankshaft. Additional counterbalancing is obtained from the balance shaft which rides in the engine block above the camshaft and is driven by the camshaft. All 3800 engines are even-firing, the cylinders fire at equal 120 degree intervals of crankshaft rotation. The location of the crankshaft journals has been offset by 30 degrees to fire the cylinders at 120 degree intervals of crankshaft rotation. The camshaft lobes and timing also reflect the 120 degree intervals. The even firing crankshaft provides an equal interval of 120 degrees between ignition of each of the cylinders throughout the firing order. The firing order is 1-6-5-4-3-2. The aluminum alloy pistons have slipper skirts and are cam turned. Four drilled holes or casted slots in the oil ring grooves permit drain back of the oil collected by the oil ring. The camshaft is supported by four bearings in the engine block and is driven by the crankshaft through sprockets and a timing chain. The cylinder heads are cast iron and incorporate integral valve stem guides. Right and left cylinder heads are identical and are interchangeable, but it is good practice to

reinstall the cylinder heads on the side from which they are removed. The intake manifold is bolted to the inner faces of both cylinder heads so it connects with all inlet ports.

Each exhaust and intake valve has a valve spring to insure positive seating throughout the operating speed range. The valve rocker arms for each bank of the cylinders pivot on pedestals bolted to the cylinder head. Hydraulic roller valve lifters and tubular push rods are used to operate overhead rocker arms and valves of both banks of the cylinders from a single camshaft. This system requires no lash adjustment at the time of assembly or service.

In addition to its normal function of a cam follower, each valve lifter also serves as an automatic adjuster which maintains zero lash in the valve train under all operating conditions. By eliminating all lash in the valve train and also providing a cushion of oil to absorb operating shocks, the valve lifter promotes quiet valve operation. It also eliminates the need for periodic valve adjustment to compensate for wear of parts. Oil is supplied to the valve lifter through a hole in the side of the valve lifter body which indexes with a groove and a hole in the valve lifter plunger. Oil is then metered past the oil metering valve in the valve lifter, through the push rods to the valve rocker arms. When the valve lifter begins to move up the camshaft lobe, the check ball is held against its seat in the plunger by the check ball spring which traps the oil in the base of the valve lifter body below the plunger.

The plunger and the valve lifter body then raise as a unit, pushing up the push rod to open the valve. The force of the valve spring which is exerted on the plunger through the valve rocker arm and push rod, causes a slight amount of leakage between the plunger and the valve lifter body. This leakage allows a slow escape of trapped oil in the base of the valve lifter body. As the valve lifter rolls down the other side of the camshaft lobe and reaches the base circle or valve closed position, the plunger spring quickly moves the plunger back (up) to its original position. This movement causes the check ball to open against the ball spring and any oil inside the plunger is drawn into the base of the valve lifter. This restores the valve lifter to the zero lash.

## **NEW PRODUCT INFORMATION**

The purpose of New Product Information is to highlight or indicate important product changes from the previous model year.

Changes may include one or more of the following items:

- A component comparison from the previous year
- Fastener changes
- Torque values and/or fastener tightening strategies
- Changed engine specifications

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- New sealants and/or adhesives
- Disassembly and assembly procedure revisions
- Engine mechanical diagnostic procedure revisions
- New special tools required

#### **Component Comparison**

No component comparison changes for 2006.

#### **Fastener Changes**

No fastener changes for 2006.

#### **Torque Values and/or Fastener Tightening Strategies**

No torque value changes for 2006.

#### **Changed Engine Specifications**

No specification changes for 2006.

#### **New Sealants and/or Adhesives**

No new sealants and or adhesives for 2006.

#### **Disassembly and Assembly Procedure Revisions**

No changes for 2006.

#### **Engine Mechanical Diagnostic Procedure Revisions**

No revisions for 2006.

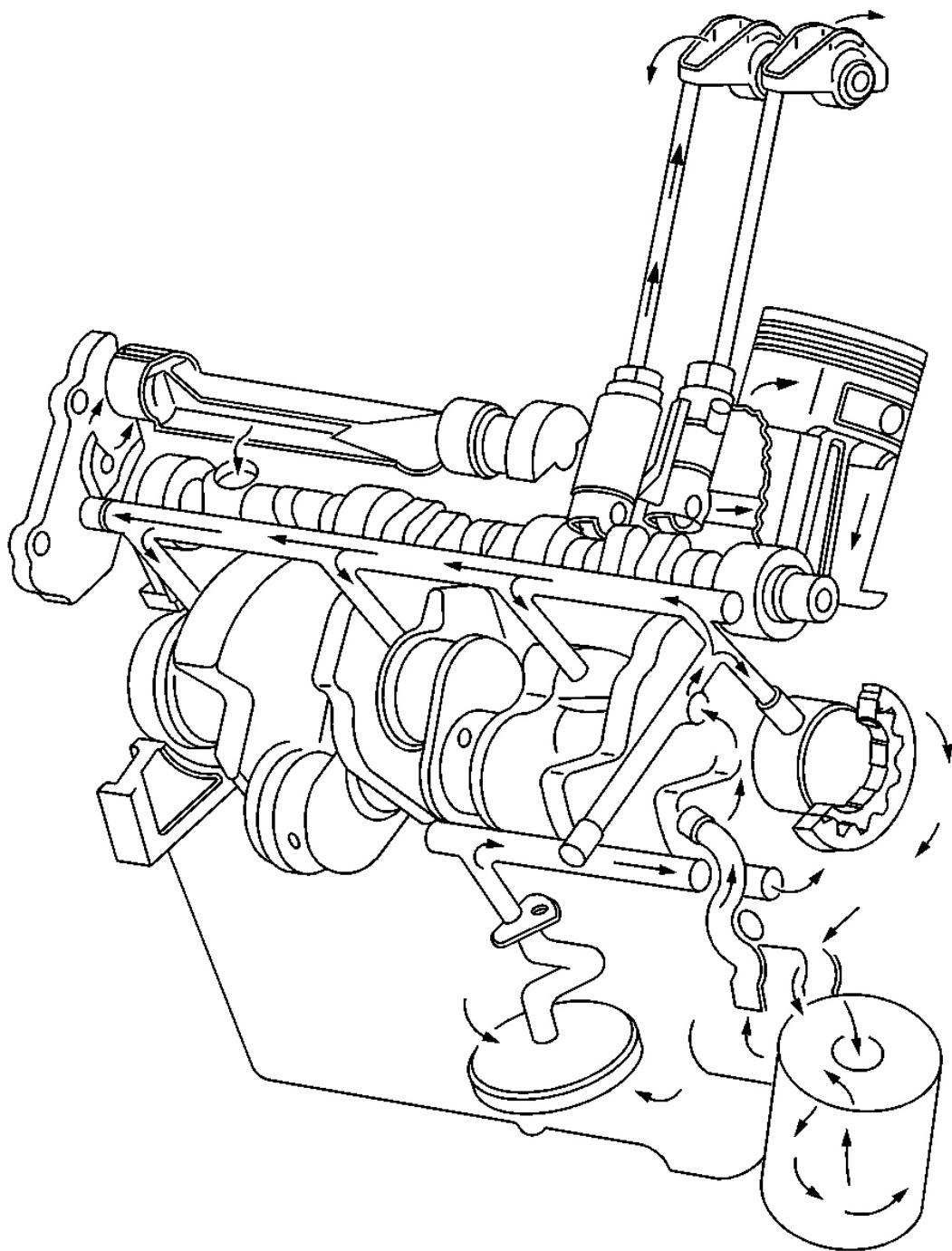
#### **New Special Tools Required**

No special tool changes for 2006.

## **LUBRICATION DESCRIPTION**

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**Fig. 518: Identifying Engine Lubrication System**  
Courtesy of GENERAL MOTORS CORP.

The engine lubrication system is of the force-feed type. The oil is supplied under full pressure to the crankshaft, connecting rods, valve lifters, camshaft and rear balance shaft bearing. A controlled volume of oil is supplied to the valve rocker arms and push rods. All other moving parts are lubricated by gravity flow or splash. The engine oil is stored in the lower crankcase (oil pan) which is filled through a filler opening in the valve rocker arm cover. A removable oil level indicator, on the left side of the engine block, is provided to check the oil level. The oil pump is located in the engine front cover and is driven by the crankshaft. It is a gerotor-style pump which is a combination of a gear and a rotor pump. It is connected by a passage in the cylinder block to an oil screen and pipe assembly. The screen is submerged in the oil supply and has ample volume for all operating conditions. If the screen becomes clogged, oil may be drawn into the system through the oil pressure relief valve in the oil filter adapter. Oil is drawn into the pump through the screen and pipe assembly and a passage in the crankcase, connecting to the passages in the engine front cover. Oil is discharged from the oil pump to the oil filter adapter. The oil filter adapter consists of an oil filter bypass valve and a nipple for installation of an oil filter. The spring-loaded oil pressure relief valve, located in the engine front cover, limits the oil pressure. The oil filter bypass valve opens when the oil filter is restricted to approximately 68.95 kPa (10 psi) of pressure difference between the oil filter inlet and discharge. The oil will then bypass the oil filter and channel unfiltered oil directly to the main oil galleries of the engine. A full-flow oil filter is externally mounted to the oil filter adapter on the lower right front side of the engine. If the filter element becomes restricted, not allowing engine oil to pass through, a spring-loaded bypass valve opens. The main oil galleries run the full length of the engine block and cut into the valve lifter guide holes to supply oil at full pressure to the valve lifters. Holes, drilled from the crankshaft bearings to the main oil gallery, intersect the camshaft bearing bores to supply oil to the cam bearings.

Oil is transferred from the crankshaft bearings to the connecting rod bearings through holes drilled in the crankshaft. Pistons, piston pins and cylinder walls are lubricated by oil splash from the crankshaft and connecting rods.

Each valve rocker arm and valve is supplied with oil through the tubular push rod. The oil comes from the inside of the valve lifter passing around the metering valve and through a hole in the push rod seat. Oil from the push rod passes through a hole in the push rod seat and emerges on top of the push rod seat boss.

#### **CLEANLINESS AND CARE**

An automobile engine is a combination of many of the following surfaces:

- Machined
- Honed

- Polished
- Lapped

The tolerances of these surfaces are measured in the ten-thousandths of an inch. When you service any internal engine part, cleanliness and care are important. Apply a liberal coating of engine oil to the friction areas during assembly in order to protect and lubricate the surfaces on initial operation. Throughout this article practice proper cleaning and protection procedures to the machined surfaces and to the friction areas.

**NOTE: Engine damage may result if an abrasive paper, pad or motorized wire brush is used to clean any engine gasket surfaces.**

Whenever you remove the valve train components, keep the components in order. Follow this procedure in order to install the components in the same locations and with the same mating surfaces as when removed.

**CAUTION: Refer to BATTERY DISCONNECT CAUTION .**

Disconnect the negative battery cables before you perform any major work on the engine.

### **SEPARATING PARTS**

The components of an internal combustion engine develop wear patterns with their mating components. During disassembly of the engine, parts should be separated and kept in order so they may be reinstalled in the same location from which they were removed.

### **REPLACING ENGINE GASKETS**

1. Do not reuse any gasket unless otherwise specified. Reusable gaskets will be identified in the service procedure. Do not apply sealant to any gasket or sealing surface unless called out in the service procedure.
2. Use a rubber mallet in order to separate components. Bump the part sideways in order to loosen the components. Perform the bumping at the bends or at the reinforced areas in order to prevent the distortion of components.

**IMPORTANT: Do not use any other method or technique in order to remove the gasket material from a components.**

**Do not use the following items in order to clean the gasket surfaces:**

- Abrasive pads
- Sand paper
- Power tools

**These methods of cleaning may damage the component. Abrasive pads also produce a fine grit that the oil filter cannot remove from the oil. This grit is abrasive and may cause internal engine damage.**

3. Remove all of the gasket and the sealing material from the component using a plastic or a wood scraper. Do not gouge or scrape the sealing surfaces.

**IMPORTANT: Do not allow the sealant to enter any blind threaded holes. The sealant may cause the following conditions:**

- Prevent you from properly seating the bolt
- Cause damage when you tighten the bolt

4. When assembling components, use only the sealant specified in the service procedure. Ensure that the sealing surfaces are clean and free of debris or oil. When applying sealant to a component, apply a bead size as specified in the service procedure.
5. Tighten the bolts to the specifications.

#### **USE OF ROOM TEMPERATURE VULCANIZING (RTV) AND ANAEROBIC SEALER**

The following 2 types of sealer are commonly used in engines:

- The RTV sealer
- The anaerobic gasket eliminator sealer

Follow the service procedure instructions. Use the correct sealer in the proper place in order to prevent oil leaks. Do not interchange the 2 types of sealers. Use the sealer recommended in the service procedure.

##### **Applying RTV Sealer**

- Do not use the room temperature vulcanizing (RTV) sealant in areas where extreme temperatures are expected. These areas include the following locations:

- The exhaust manifold
- The head gasket
- The other surfaces where gasket eliminator is specified
- Use a rubber mallet in order to separate the components sealed with RTV sealant. Bump the part sideways in order to shear the RTV sealer. Perform the bumping at the bends or the reinforced areas in order to prevent distortion of the components. The RTV sealant is weaker in shear (lateral) strength than in tensile (vertical) strength.

**IMPORTANT: Do not use any other method or technique in order to remove the gasket material from a component.**

- Do not use the following items in order to clean the gasket surfaces:
  - Abrasive pads
  - Sand Paper
  - Power tools

These methods of cleaning may damage the part.

Abrasive pads also produce a fine grit that the oil filter cannot remove from the oil. This grit is abrasive and may cause internal engine damage.

- Remove all of the gasket material from the component using a plastic or a wood scraper. Use Loctite® brand gasket remover P/N 4MA or the equivalent. Follow all of the safety recommendations and the directions that are on the container.

**IMPORTANT: Do not allow the sealer to enter the blind threaded holes. The sealer may cause the following conditions:**

- Prevent you from properly seating the bolt
- Cause damage when you tighten the bolt
- Apply the RTV sealant to a clean surface. Use a bead size as specified in the procedure. Apply the bead to the inside of any bolt holes.
- Assemble the components while the RTV sealant is still wet (within 3 minutes). Do not wait for the RTV sealant to skin over.

**IMPORTANT: Do not overtighten the bolts.**

- Tighten the bolts to specifications.

### Applying Anaerobic Sealer

The anaerobic gasket eliminator hardens in the absence of air. This type of sealer is used where 2 rigid parts (such as castings) are assembled together. When 2 rigid parts are disassembled and no sealer or gasket is readily noticeable, the parts were probably assembled using a gasket eliminator.

**IMPORTANT: Do not use any other method or technique in order to remove the gasket material from a component.**

Do not use the following items in order to clean the gasket surfaces:

- Abrasive pads
- Sand paper
- Power tools

These methods of cleaning may damage the part.

Abrasive pads also produce a fine grit that the oil filter cannot remove from the oil. This grit is abrasive and may cause internal engine damage.

- Remove all of the gasket material from the component using a plastic or a wood scraper. Use Loctite® brand gasket remover P/N 4MA or the equivalent. Follow all of the safety recommendations and the directions that are on the container.
- Apply a continuous bead of the gasket eliminator to 1 flange. Clean and dry any surfaces that you will reseal.

**IMPORTANT: Anaerobic sealed joints that are partially torqued and allowed to cure more than 5 minutes may result in incorrect shimming and sealing of the joint.**

- Do not allow the sealer to enter the blind threaded holes. The sealer may cause the following conditions:
  - Prevent you from properly seating the bolt
  - Cause damage when you tighten the bolt
- Spread the sealer evenly in order to get a uniform coating on the sealing surface.
- Tighten the bolts to the specifications.
- Remove the excess sealer from the outside of the joint.

## TOOLS AND EQUIPMENT

Work in a clean and well-lit area. Have the following components available before you begin to work:

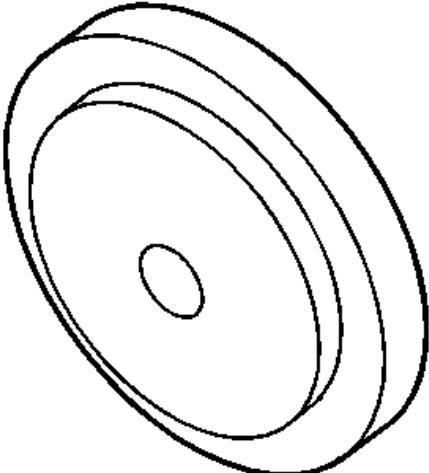
- A suitable parts cleaning tank
- A compressed air supply
- Trays, in order to keep the parts and the fasteners organized
- An adequate set of hand tools

An approved engine repair stand will prevent personal injury or damage to the engine components. The special tools are designed in order to quickly and safely accomplish the operations for which the tools are intended. Using the tools will minimize possible damage to the engine components. Precision measuring tools are required for the inspection of certain critical components. Torque wrenches are needed for the correct assembly of various parts.

## SPECIAL TOOLS AND EQUIPMENT

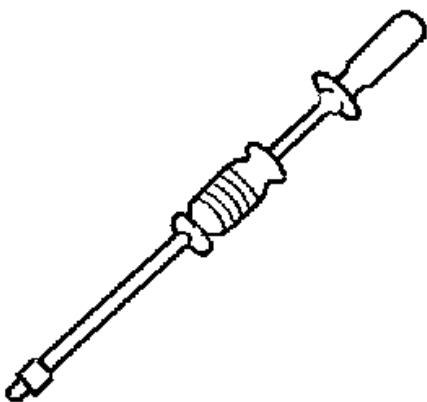
### SPECIAL TOOLS

#### Special Tools

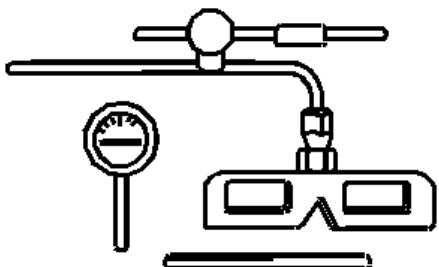
Illustration	Tool Number/Description
	EN 47623 Rear Main Seal Installer

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J 6125-1B  
Slide Hammer

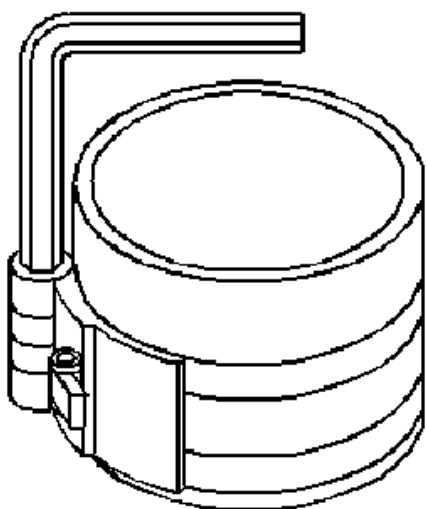
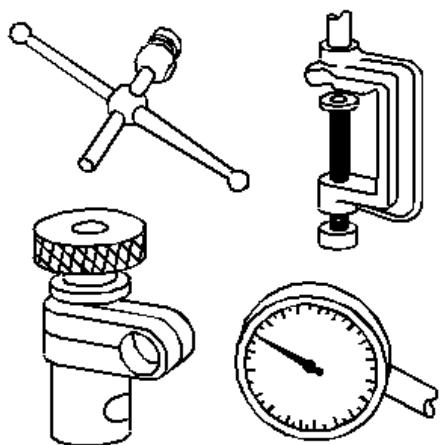


J 7872  
Magnetic Base Indicator Set

J 8001  
Dial Indicator Set

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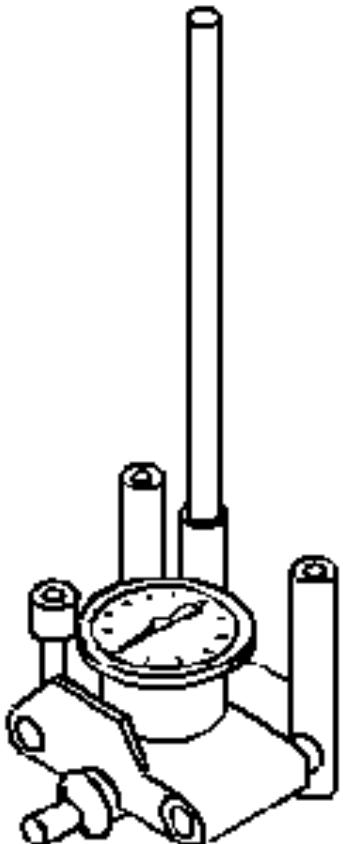
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J 8037  
Piston Ring Compressor

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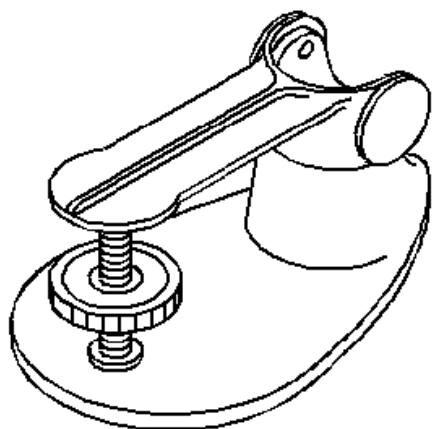
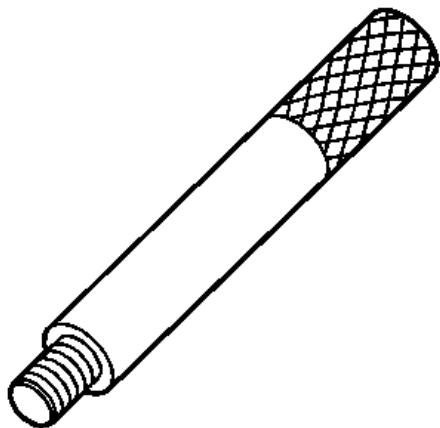


**J 8087**  
**Cylinder Bore Gage**

**J 8092**  
**Drive Handle**

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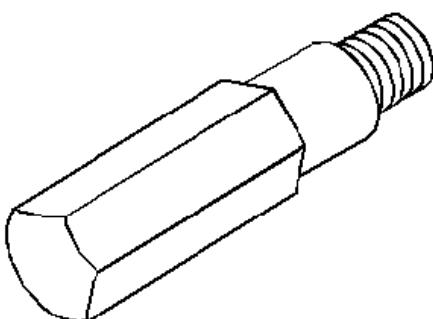
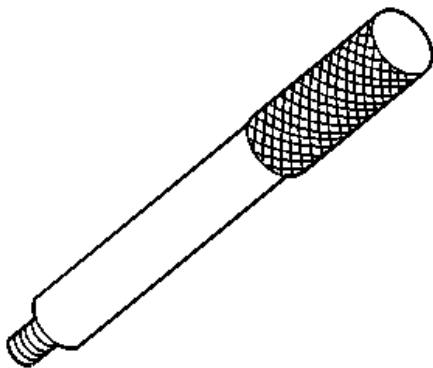


**J 9666**  
Valve Spring Tester

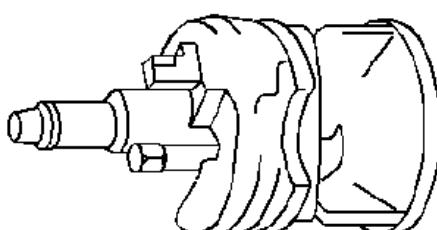
**J 21465-13**  
Drive Handle Extension

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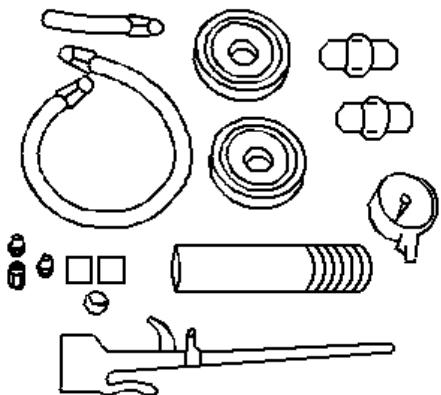
**J 23590**  
Spark Plug Port Adapter



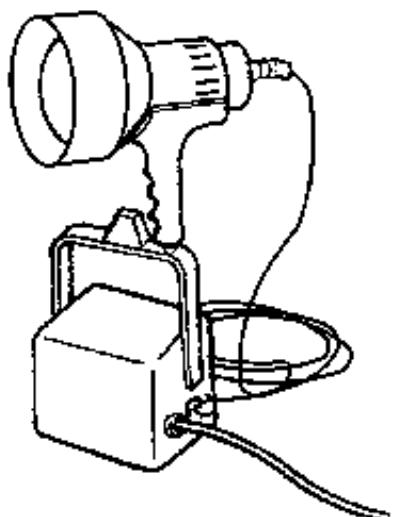
**J 24270**  
Cylinder Ridge Reamer

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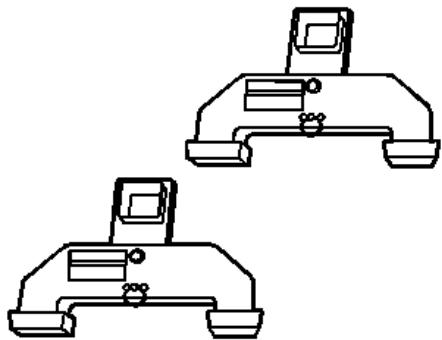
**J 25087-C**  
Oil Pressure Tester and Pump Primer



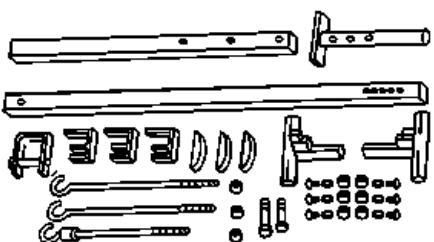
**J 28428-E**  
High Intensity Black Light

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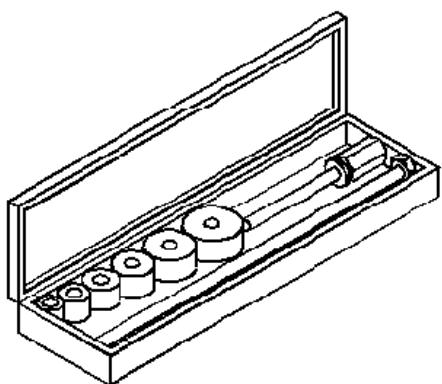
### 2006 ENGINE Engine Mechanical - 3.8L - Lucerne



**J 28467-501**  
Engine Support Fixture Adapters



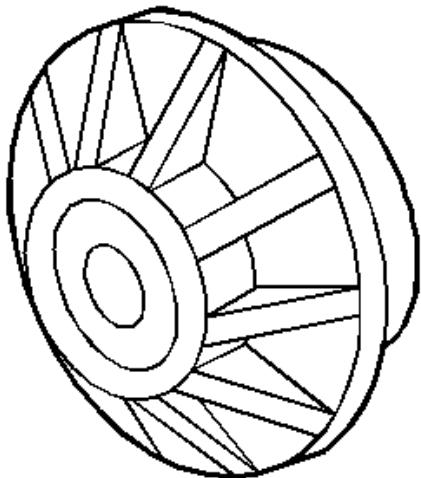
**J 28467-B**  
Universal Engine Support Fixture



**J 33049**  
Camshaft Bearing Service Set

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**J 35354**  
Seal Installer



**J 35667-A**  
Cylinder Head Leakdown Tester

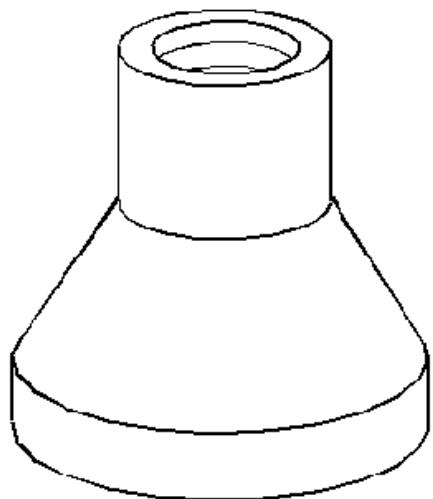
**2006 Buick Lucerne CXS**

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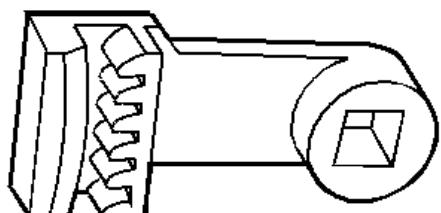
**J 36995**

Balance Shaft Bearing Remover/Installer



**J 36996**

Balance Shaft Installer

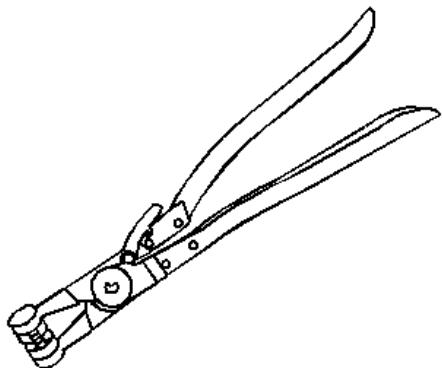


**J 37096**

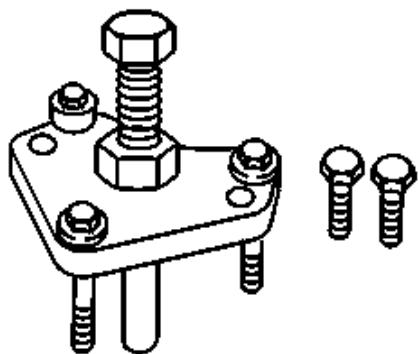
Flywheel Holding Tool

**2006 Buick Lucerne CXS**

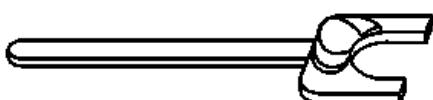
2006 ENGINE Engine Mechanical - 3.8L - Lucerne



**J 38185**  
Hose Clamp Pliers



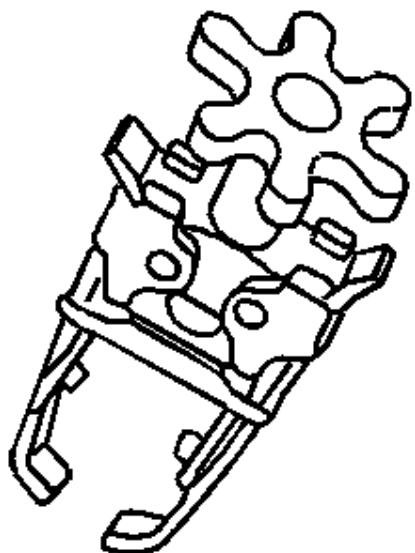
**J 38197-A**  
Crankshaft Balancer Remover



**J 38491**  
Spark Plug Boot Removal Tool

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**J 38606**  
Valve Spring Compressor

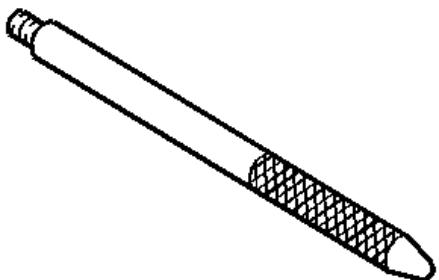
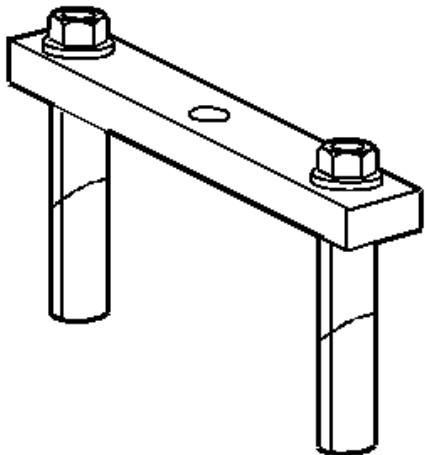


**J 38722**  
Compression Tester

**J 41348**  
Main Bearing Cap Puller

## 2006 Buick Lucerne CXS

2006 ENGINE Engine Mechanical - 3.8L - Lucerne

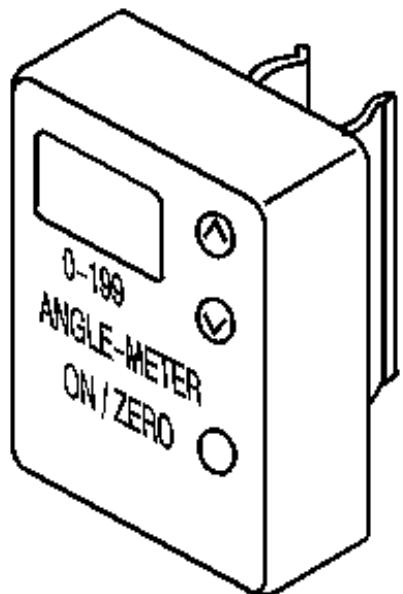
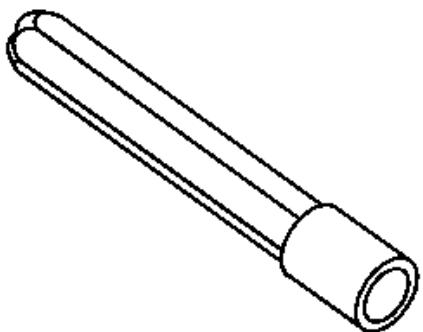


**J 41507**  
Connecting Rod Assembly Guide

**J 42863**  
Valve Stem Seal Installer

## 2006 Buick Lucerne CXS

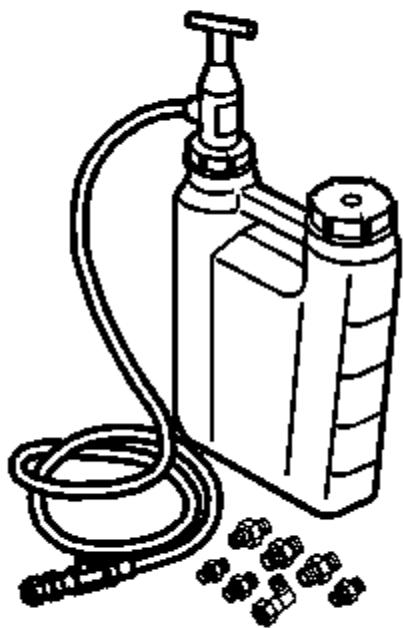
2006 ENGINE Engine Mechanical - 3.8L - Lucerne



J 45059  
Angle Meter

## 2006 Buick Lucerne CXS

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J 45299  
Engine Preluber